

48. The Nematode Genus *Physaloptera* Rud.* By R. J. ORTLEPP, M.A., Research Assistant, Dept. of Helminthology, London School of Tropical Medicine; Hon. Parasitologist to the Society 1921-1922.

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(Text-figures 1-44.)

CONTENTS.	Page
Introduction	999
Material and Acknowledgments	1002
Methods of Study.....	1003
General Characters of <i>Physaloptera</i>	1004
Characters of Systematic Importance	1007
Systematic Section	1011
Part I.....	1011
Part II.	1081
Species Inquirendæ	1100
Species wrongly attributed to the genus	1161
Bibliography	1104
Index of Species	1107

INTRODUCTION.

Rudolphi (1819), when establishing the genus *Physaloptera* expressed some doubt as to its validity. He gives the following as its generic diagnosis:—"Corpus teres elasticum utrinque attenuatum. Os orbiculare. Cauda maris deflexa utrinque alata, vesicam inferam sistens. Penis tuberculo emissus." Dujardin (1845), after quoting Rudolphi's doubt, suppressed the genus and transferred the species to the genus *Spiroptera*. Diesing (1851) re-established the genus, and defined it in such a way that it could not be confused with any other genus of Nematodes. He added two more species, one of which—*Ph. mucronata*—was found to be an Ascarid by Molin.

Leidy (1856) gave a short and incomplete description of four more species, two of which—*Ph. constricta* and *Ph. contorta*—can be definitely ruled out from the genus, as they probably belong to the family *Gnathostomidae* as redefined by Baylis and Lane (1920).

Up to the appearance of Molin's monograph on the genus in 1860, 18 species had been described as belonging to it, namely 9 by Rudolphi, 2 by Creplin, 4 by Leidy, 2 by Diesing, and 1 by Hemprich and Ehrenberg. Of these, 5 are not members of the genus and 1 is doubtful.

* Communicated by Prof. R. T. LEIPER, F.Z.S.

Molin's monograph contains the descriptions of 22 species, of which 9 are new and 4—*Ph. colubri* (Rud., 1918), Dies., 1851, *Ph. limbata* Leidy, 1856, *Ph. abjecta* Leidy, 1856, and *Ph. spirula* Hempr. & Ehren., 1828—are listed under Species Inquirendæ. In his introduction to this work he eliminates the four species *Ph. strongylina* Rud., *Ph. mucronata* Dies., *Ph. saginata* Rud., and *Ph. tenuicollis* Rud. from the genus, stating that *Ph. mucronata* and *Ph. tenuicollis* are Ascarids, *Ph. saginata* a Spiroptera, and that *Ph. strongylina* belongs to a new genus. He places *Ph. megalostoma* Crep., 1829, as a synonym of *Ph. alata* Rud.

Schneider, in his 'Monographie der Nematoden' (1866), describes 9 species of Physaloptera, of which 4 are new, namely *Ph. digitata*, *Ph. subalata*, *Ph. truncata*, and *Ph. spiralis*. Prior to his publication, and after the appearance of Molin's monograph, the only other new Physaloptera described is *Ph. muris-brasiliensis* Diesing, 1861, from *Mus brasiliensis*.

In 1883, von Drasche amplified Molin's monograph by publishing a revision of the Molin and Diesing types deposited in the Vienna Museum; his work is of considerable value, as he paid special attention to the structure of the lips and caudal extremity of the males, and also gave figures of them all. He confirmed Molin's diagnosis that *Ph. mucronata* Dies., 1851, is an Ascarid.

Von Linstow, in his 'Compendium der Helminthologie' (1878) and in his "Nachtrag" (1889) to this work, records 40 species—31 in the first work and 9 additional ones in the latter.

The next landmark was the appearance of Stossich's monograph on the genus in 1889. He here gave the description of 37 species, 26 of which he considered valid, and the rest he listed under Species Inquirendæ. Those species referred to in this work and not in Molin's are as follows:—1 species—*Ph. torquata*, of Leidy, 1886; 5 species of von Linstow—*Ph. crassa*, 1879, *Ph. dentata*, 1883, *Ph. malleus*, 1883, *Ph. striata*, 1883, and *Ph. pyramidalis*, 1879; 4 species—*Ph. digitata*, *Ph. spiralis*, *Ph. subalata*, and *Ph. truncata*, described by Schneider in 1886; and 1 species of Diesing—*Ph. muris-brasiliensis*, 1861. Of Stossich's 37 species, 11 are recorded from reptiles, 11 from birds, and 15 from mammals.

In 1911, Gedoelst published his 'Synopsis de Parasitologie,' in which he listed 5 species, viz. 2 from man, 1 from carnivores, and 2 from birds.

Hall (1916) gives the descriptions of 7 species, viz. 1 from Hyracoidea, 5 from rodents, and 1, *Ph. abbreviata*, which is a reptilian parasite, but had been recorded from *Graphiurus murinus* by Parona (1909). Hall doubts Parona's diagnosis, and I agree with him that the presence of this parasite in a rodent is very suggestive of an error in its identification.

Up to the present day the number of species has been considerably increased, thanks principally to von Linstow and

Seurat. Von Linstow added 19 species to those of his mentioned above, one—*Ph. amphibia*—being the only record of the occurrence of a member of this genus in amphibians, and another—*Ph. caucasica*—being the first species described from man. Seurat has added 8 new species and two varieties of *Ph. alata*, Rud., 1819.

The latest addition to the literature of this group is two papers by Irwin-Smith reviewing the parasites found in reptiles. In her first paper (1921) she gives a host list of all the reptilian Physaloptera, as well as a bibliographical catalogue in connection with them. In her second paper (1922) she brings together the description of 13 species, all from lizards, and states that of the 15 species recorded from this group of reptiles, only 9, perhaps 10, are valid, the others being either synonyms or not members of this genus.

In Stiles and Hassall's 'Index Catalogue of Round-worms' (1920) 80 species and 2 varieties of Physaloptera are listed, many of which, however, are either synonyms or do not belong to this genus. The addition of 3 species by Gedoelst (1916), 1 by Hall and Wigdor (1918), and 1 by Travassos (1920) not listed in the catalogue, and 7 new species described in this paper brings the number recorded up to 92. These are distributed among the principal host groups as follows:—43 species from mammals, 20 species and 2 varieties from birds, 28 species from reptiles, 1 species from amphibians, and 1 species, *Ph. bonnei*, sp. n., from a host in Dutch Guiana of which its native name is "Sapakara," but of which I have been unable to obtain the scientific name.

The following list comprises all the species recorded from each of these host groups:—

AMPHIBIA.

Ph. amphibia v. Linst., 1899.

REPTILIA.

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|---|--------------------------------------|
| <i>Ph. abbreviata</i> Rud., 1819. | <i>Ph. longissima</i> , sp. n. |
| <i>Ph. abjecta</i> Leidy, 1856. | <i>Ph. monodens</i> Mol., 1860. |
| <i>Ph. affinis</i> Gedoel., 1916. | <i>Ph. mucronata</i> Dies., 1851. |
| <i>Ph. alba</i> Stoss., 1902. | <i>Ph. obtusissima</i> Mol., 1860. |
| <i>Ph. aloisii-sabaudie</i> Par., 1907. | <i>Ph. pallaryi</i> Seurat, 1917. |
| <i>Ph. antarctica</i> v. Linst., 1899. | <i>Ph. paradoxa</i> v. Linst., 1908. |
| <i>Ph. britanica</i> Skrjabin, 1916. | <i>Ph. phrynosoma</i> , sp. n. |
| <i>Ph. chameleontis</i> Gedoel., 1916. | <i>Ph. quadrovavia</i> Leiper, 1908. |
| <i>Ph. colubri</i> (Rud., 1819), Dies., 1851. | <i>Ph. retusa</i> Rud., 1819. |
| <i>Ph. constricta</i> Leidy, 1856. | <i>Ph. simplicidens</i> , sp. n. |
| <i>Ph. contorta</i> Leidy, 1856. | <i>Ph. sonsinoi</i> v. Linst., 1895. |
| <i>Ph. dentata</i> v. Linst., 1883. | <i>Ph. spiralis</i> Schn., 1866. |
| <i>Ph. gracilis</i> , sp. n. [1917. | <i>Ph. striata</i> v. Linst., 1883. |
| <i>Ph. leptosoma</i> (Gerv., 1848), Seurat, | <i>Ph. varani</i> , Paroua, 1839. |

AVES.

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| <i>Ph. acuticauda</i> Mol., 1860. | <i>Ph. inflata</i> (Mol., 1860), Stoss., 1889. |
| <i>Ph. alata</i> Rud., 1819. | <i>Ph. malleus</i> v. Linst., 1883. |
| " " v. <i>chevreuxi</i> Seurat, 1914. | <i>Ph. megalostoma</i> Crep., 1829. |
| " " v. <i>nouveli</i> Seurat, 1915. | <i>Ph. ovata</i> v. Linst., 1907. |
| <i>Ph. bilabiata</i> Crep., 1829. | <i>Ph. rotundata</i> v. Linst., 1906. |
| <i>Ph. brevicauda</i> v. Linst., 1909. | <i>Ph. saginata</i> Rud., 1819. |
| <i>Ph. bulbosa</i> v. Linst., 1906. | <i>Ph. striata</i> v. Linst., 1883. |
| <i>Ph. crassa</i> v. Linst., 1879. | <i>Ph. strongylina</i> Rud., 1819. |
| <i>Ph. crosi</i> Seurat, 1914. | <i>Ph. subalata</i> Schn., 1866. |
| <i>Ph. fusiformis</i> v. Linst., 1902. | <i>Ph. tenuicollis</i> Rud., 1819. |
| <i>Ph. galinieri</i> Seurat, 1914. | <i>Ph. truncata</i> Schn., 1866. |

MAMMALIA.

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| <i>Ph. anomala</i> Mol., 1860. | <i>Ph. maxillaris</i> Mol., 1830. |
| <i>Ph. brevispiculum</i> v. Linst., 1906. | <i>Ph. mephites</i> Solanet, 1909. |
| <i>Ph. brevivaginata</i> Seurat, 1917. | <i>Ph. mordens</i> Leiper, 1908. |
| <i>Ph. capensis</i> , sp. n. | <i>Ph. muris-brasiliensis</i> Dies., 1861. |
| <i>Ph. caucasica</i> v. Linst., 1902. | <i>Ph. nasilionis</i> Gedoel., 1916. |
| <i>Ph. cesticillata</i> , Sons., 1889. | <i>Ph. numidica</i> Seurat, 1917. |
| <i>Ph. circularis</i> v. Linst., 1897. | <i>Ph. papilloradiata</i> v. Linst., 1899. |
| <i>Ph. citilli</i> (Rud., 1819), Hall, 1916. | <i>Ph. papillotruncata</i> Mol., 1860. |
| <i>Ph. clausa</i> Rud., 1819. | <i>Ph. præputialis</i> v. Linst., 1889. |
| <i>Ph. cœlebs</i> v. Linst., 1897. | <i>Ph. pyramidalis</i> v. Linst., 1879. |
| <i>Ph. digitata</i> Schn., 1863. | <i>Ph. rara</i> Hall & Wigdor, 1918. |
| <i>Ph. dilatata</i> Rud., 1819. | <i>Ph. ruvenzorii</i> Parona, 1907. |
| <i>Ph. dispar</i> v. Linst., 1904. | <i>Ph. semilanceolata</i> , Mol., 1860. |
| <i>Ph. elegantissima</i> Stoss., 1902. | <i>Ph. sciuri</i> Parona, 1898. |
| <i>Ph. gemina</i> v. Linst., 1899. | <i>Ph. spirula</i> Hempr. & Ehren., 1828. |
| <i>Ph. getula</i> Seurat, 1917. | <i>Ph. tacapensis</i> Seurat, 1917. |
| <i>Ph. guiarti</i> Garin, 1913. | <i>Ph. terdentata</i> Mol., 1860. |
| <i>Ph. incurva</i> v. Linst., 1908. | <i>Ph. torquata</i> Leidy, 1886. |
| <i>Ph. inermis</i> v. Linst., 1906. | <i>Ph. torresi</i> (Trav., 1920). [1912. |
| <i>Ph. limbata</i> Leidy, 1856. | <i>Ph. tumefaciens</i> Henry & Blanc, |
| <i>Ph. magnipapilla</i> Mol., 1860. | <i>Ph. turgida</i> Rud., 1819. |
| <i>Ph. malayensis</i> , sp. n. | |

Doubtful Host.

- Ph. bonnei*, sp. n.

MATERIAL AND ACKNOWLEDGMENTS.

The present work originated in the examination and determination of a number of species of this genus collected by the author at the Prosectorium of the Zoological Society of London, while holding the post of Parasitologist to the Society. Prof. Leiper suggested that the work should be extended, so as to include a redescription of as many as possible of the recorded species of this genus, together with a survey of the whole group. With this aim in view he handed over to me, for study and identification, his valuable collection of Physaloptera, most of which had been personally collected by him during his expedition

to Uganda in 1906. I wish here to express my indebtedness and thanks to the Zoological Society of London for the honour and privilege of collecting these parasites in their Gardens, and to Professor Leiper my sincere thanks and gratitude for having entrusted me with his material, for his valuable advice and criticisms, without which the work could not have been undertaken, and for the use of his valuable library.

In addition to the above material, the writer was able to examine representative material of all of Molin's species, the types of two of Diesing's species, and examples of six of Rudolphi's, including his types of *Ph. clausa* deposited in the Helminthological collection of the Zoologische Abteilung der Naturhistorischen Staatsmuseum, Vienna. I wish to express my indebtedness and thanks to Hofrat Dr. Ludwig von Lorenz-Liburnaü, Director of the Zoological Department, for the privilege afforded me to examine this material, and especially also to Dr. Carl Graf Attems, custodian of the Helminthological collection in the Museum, for the excellent facilities so generously placed at my disposal.

Molin did not set apart any material of his species as types, neither did von Drasche when re-examining Molin's material. In consequence of this, I have taken the bottle with the lowest number to represent the type, except in the case of *Ph. obtusissima* and *Ph. terdentata*. In the former case a paratype of the species was examined; in the second case the bottle with the lowest number did not contain Molin's species, but a representative of a later-described species of von Linstow's, namely *Ph. præputialis*; consequently a bottle without any regular number upon it, but with the legend Y1074 on the stopper, was taken as the type; this material had been determined by Molin and also redetermined by von Drasche. The number of the bottles containing what I have taken as the type materials of Rudolphi's, Diesing's, and Molin's species are recorded under the description of the individual species concerned.

The types of the two new species, *Ph. phrynosoma* and *Ph. capensis*, described in this paper will be deposited in the British Museum of Natural History. The types of the five other new species, *Ph. gracilis*, *Ph. longissima*, *Ph. simplicidens*, *Ph. malayensis*, and *Ph. bonnei*, are in the Helminthological Department of the London School of Tropical Medicine.

METHODS OF STUDY.

The fresh material obtained from the Prosectorium of the London Zoological Society was collected and washed in normal saline, and as much as possible of the structure of the worms determined while they were still in the living state. They were then killed in hot 70 per cent. alcohol, according to the method recommended by Looss, after which they were preserved in a 70 per cent. alcohol + 5 per cent. glycerine solution. For

further study of this, and the rest of the material it was necessary to render them transparent by some clearing medium. Langeron's lactophenol was at first used, but, although this medium is excellent for small nematodes, it did not give satisfactory results with the larger members of this group, as it did not render the specimen clear enough to make out the details of the spicules. Consequently beechwood creosote was used in its stead. In using this latter medium, the parasites were transferred into strong alcohol, about 95 per cent., and left therein for a longer or shorter period according to the size of the worms; after a sufficient interval to allow for the thorough penetration of this alcohol, they were placed in the creosote and examined, when clear, under the microscope by placing them on a larger slide and rolling them under a coverslip when necessary. After examination it is essential to remove the creosote from the worms, as they tend to become very dark in colour if returned into the preserving fluid without removal of the creosote. To obviate this, the parasites were first immersed for at least two hours in a 1-2 per cent. acid alcohol solution (70 per cent.), after which they could be transferred into the preserving fluid with apparent safety.

All the measurements, except that of the length of the worms, were taken by means of an ocular micrometer, the value of each of whose divisions had been previously determined.

The details of the female genitalia were made out in most species by simple clearing and rolling of the parasites; in the remaining species it was necessary to dissect out these uteri under a dissecting microscope, and to examine them separately when mounted on a slide: where, however, there was ample material of the former, the genitalia were also dissected out.

Where there was sufficient material available, the details of the lips were determined by first cutting the lips off from the body and then examining each lip from the inner and outer surface when cleared and mounted on a slide.

All the figures except one—caudal bursa of *Ph. colubri*—are original. All those accompanied by a scale were drawn by means of a camera lucida; the others are free-hand drawings made from the specimens.

GENERAL CHARACTERS OF *PHYSALOPTERA*.

These worms are rounded elongate and taper gradually in their anterior half and posterior third; they vary considerably in size, the largest specimens known being 10 cm. long and nearly 3 mm. thick. The cuticle is loosely attached to the body, and in nearly all cases is extended over the lips to form a prepuce-like collar; in a few species a similar reduplication is present over the caudal extremities of both sexes. The cuticle always shows a very fine transverse striation, which often requires high magnification for its detection.

Two cervical papillæ are present. These are situated laterally a short distance behind the cephalic extremity. They are small and spike-like, and stand out at right angles to the body.

The excretory pore is ventral in position, and is situated a very short distance posterior to the cervical papillæ. It gives exit to a thin duct, which at first passes obliquely inwards and forwards and then bends backwards to join an oval, elongate, and unicellular gland pressed against the ventral surface of the œsophagus.

Two lips are present. These are lateral in position, and have their inner faces flattened and their outer somewhat convex; in lateral view they may be semicircular, dome-shaped, or more or less triangular in outline. They are always simple and their pulp is never subdivided. Each lip carries a variable number of teeth on its anterior and inner border; these consist typically of: (1) an outer median tooth, generally triangular in shape and of variable size; (2) an inner median tooth immediately internal to the outer median: it may be larger, smaller, or of the same size as the outer tooth, and its tip may be either simple and pointed or broadened out and tripartite; (3) two inner lateral teeth, one situated in each of the submedian fields of each lip on its inner surface: they are smaller than the outer tooth and are always split; (4) a series of small denticles arranged in a linear series on the inner surface of the lip, dorsad and ventrad of the median teeth. The external median tooth is always present, but any or all of the other teeth can be absent. Two papillæ are present on the external surface of each lip; these are situated one in each submedian field towards the angles of the lips; they are generally dome-shaped. A number of observers mention the presence of an additional external papilla in the mid-line of the lip. I have not detected any such papillæ in any of the specimens studied, and I am consequently led to the conclusion that a small shoulder-like bulging, sometimes present on the outer surface of the lip, has been mistaken for a papilla.

The œsophagus is a straight and cylindrical organ, increasing slightly in thickness towards its posterior extremity. It is always divisible into two parts, namely, a short, transparent, and slightly thinner anterior muscular portion showing transverse muscular striations, and a posterior glandular portion which is thicker, opaque, and granular. Its lumen is lined with chitin and is triradiate. Seurat mentions the presence of a buccal cavity between the lips and œsophagus. I was not able to detect any such space in my material except in one, *Ph. gracilis*, sp. n., where I think the space was due to contraction; in all my other specimens the œsophagus immediately followed the lips.

The nerve ring is large, and encircles the muscular œsophageal portion in its posterior half.

The intestine is straight, and its connection with the œsophagus is slightly thicker than the rest of the organ, which has a uniform thickness throughout. It opens to the exterior by a

short and oblique rectum, lined internally with chitin and accompanied on its outer surface by a number of rectal glands.

The tail of the female is generally short and conical; it is supplied with a unicellular gland; two lateral caudal pores are present, situated generally behind its middle.

The male caudal extremity is incurved ventralwards, and carries on either side a cuticular expansion, which passes across the ventral surface, some short distance in front of the anus, to join its fellow of the other side. It is always supported by at least four pairs of long pedunculated papillæ, generally arranged circumlocally. Its ventral surface is nearly always ornamented either by longitudinal ridges, or with longitudinal rows of tubercles, or spikes or rounded prominences. In addition, there is present a variable number of ventral papillæ (? absent in *Ph. guiarti* Garin) which are generally sessile; typically these consist of three pre-anal and five pairs of post-anal papillæ, but this number may vary in some species.

In the female the vulva is always situated in the anterior half of the body. It is a circular aperture, generally situated on a slight elevation. It leads into an unpaired ovijectoral portion, which in its turn is followed by a double or multiple portion of the female genitalia. The ovijectoral part consists typically of three subdivisions, viz.: (1) a thick-walled cylindrical and muscular vaginal part, lined internally with chitin; (2) a middle swollen portion, generally having its lumen filled with eggs: this part I have interpreted as "egg-chamber"; and (3) a posterior cylindrical portion of about the same thickness as the vagina, but generally shorter: this part I have designated in the descriptions by the term "common trunk", as it probably represents a fused portion of the uteri. The first two parts are always present, but the last is often absent. The double or multiple parts consist of two or more tubules connected by a thinner part to the common trunk or egg-chamber, and comprising a uterus, a receptaculum seminis, an oviduct, and an ovary. The uteri are large, and are filled with numerous eggs; they fill practically the whole body-cavity, and pass backwards more or less parallel to each other to within a few millimetres from the posterior extremity; they then pass forwards, become thinner, and join on to the receptacula seminis. The receptacula seminis are small, oval, rounded, or pyriform, with their greatest diameter further away from the uteri. The oviducts are fine ducts, connecting the oviducts to the receptacula seminis; their transition into the ovaries is generally gradual, but into the receptacula it is abrupt. The ovaries are long and taper gradually to their tip: they at first pass irregularly forwards, but recurve to end generally in the anterior body half.

The eggs are relatively small, oval, smooth, and very thick-shelled, and are embryonated before being laid.

The male genital tubule is unpaired, and is situated ventrad to the digestive tract. It consists of three well-defined portions,

viz. : (1) a posterior and short but elongately pyriform ejaculatory duct, with its thickest part away from the genital orifice ; (2) a long vesicula seminalis, of the same dimensions throughout and slightly thicker than the ejaculatory duct ; and (3) a much thinner and tapering testis, which passes forwards into the anterior third of the body, after which it recurves, and passes backwards to end at about the middle of the body. The ejaculatory duct and vesicula seminalis are straight, but the testis performs irregular longitudinal loops in its forward course. The accessory male genital apparatus consists of two spicules, of which the left is generally long and slender, and the right shorter and stouter ; they may, however, be of the same length, or the right may be slightly larger than the left.

CHARACTERS OF SYSTEMATIC IMPORTANCE.

Seurat (1914) was the first to draw attention to the systematic value of the number of the uteri, and in his writings on the Physaloptera invariably groups his species according to whether they have two or four uteri. In my investigations on this genus I have found also forms possessing as many as 15 uteri, and consequently have classified them into the three groups—Didelphys, Tetradelphys, and Polydelphys.

The number of the uteri and their mode of origin from the ovijector appear to me to be characters of primary systematic value, and the question arises whether they are not of generic significance.

Irwin-Smith (1922) considers it "undesirable to establish a new genus entirely on a character which can be determined only by dissection." I agree with her that it does not appear legitimate to create a genus on only one character ; and consequently I have looked for some other characters common to each of these groups, but have not been able to find any. The whole genus is so compact, and its individual species have so many characters in common, that at the present state of our knowledge of the Physaloptera, I am compelled to retain them all in the same genus, however much I have felt inclined to split them up for the sake of convenience.

Travassos (1920) separates from the genus *Physaloptera* four new genera, limiting the genus *Physaloptera* to those forms possessing similar and subequal spicules, two uteri, four pairs of pedunculated papillæ, and having no reduplication of the cuticle over the caudal extremity. He gives the following key to these five and three other nearly related genera :—

1. Spicules similar and subequal.

A. Two uteri.

- a.* Four pairs of pedunculated papillæ ; no prepuce-like sheath at the posterior extremity *Physaloptera.*
- b.* A prepuce-like collar present at the posterior extremity ... *Chlamydonema.*
- c.* Eight pairs of pedunculated papillæ..... *Thubunæa.*

B. Ten uteri ... *Turgida.*

2. Spicules dissimilar, and their sizes very different.

AA. Two uteri.

- aa.* Four pairs of pedunculated papillæ *Abreviata.*
bb. Nine to ten pairs of pedunculated papillæ,
cc. Vulva in anterior half; ovijector very long *Heliconema.*
dd. Vulva near to the anus *Proleptus.*

BB. Four uteri *Leptosoma.*

Except for the genus *Turgida*, Travassos gives no generic diagnoses for his new genera, so that in order to form a conception of the three genera *Chlamydonema*, *Abreviata*, and *Leptosoma*, we are limited to the skeletal framework of his key. He also does not indicate which species he regards as the type of each of these three genera, but as he has used the term *Turgida* in raising the species *Ph. turgida* to generic rank, I take it that *Chlamydonema* will have as its type-species *Ph. præputialis* von Linstow, 1899, because *Chlamydonema felineus* is the name used by Hegt (1910) in describing a nematode parasite from the Domestic Cat, being apparently unaware of its physalopteran characters or its identity with *Ph. præputialis*. *Abreviata* is presumably Rudolphi's species *Ph. abbreviata* raised to generic rank, and *Leptosoma* is presumably *Ph. leptosoma* (Gervais) Seurat, 1917, raised to a new genus.

In view of Seurat's investigations and my own observations on the genus *Physaloptera*, all Travassos' genera appear to me to be untenable. *Chlamydonema*, besides the characters it has in common with Travassos' restricted genus *Physaloptera*, has in addition the prepuce-like collar over the posterior extremity; now, *Ph. tumefaciens* Henry & Blanc, 1912, also shows this characteristic, although not to such a marked extent as in *Ph. præputialis*, but as it has four uteri, it cannot be included in the genus *Chlamydonema*, so that this genus is not valid.

The genus *Turgida* has all the characters of the genus *Physaloptera* as restricted by Travassos, except that it is polydelphoid, so that its validity is based on this single characteristic. As shown above, I do not regard the multiplication of the uteri by itself as of more than specific value. *Ph. capensis*, sp. n., is also polydelphoid, but the mode of origin of its uteri is quite different from that in *Ph. turgida*, so that if the genus *Turgida* is accepted, then a special genus would have to be created for *Ph. capensis*, a procedure which I consider quite unjustifiable.

Ph. abbreviata, as redescribed by Seurat (1914 *b*), has four uteri, so that on this ground alone the genus *Abreviata* must be suppressed, as Travassos creates it for those forms possessing two uteri and having very equal and dissimilar spicules; besides, the tetradelphoid species *Ph. tumefaciens* and *Ph. magnipapilla* have only slightly unequal spicules, which character also does not tally with Travassos' conception of his new genus.

The genus *Leptosoma*, according to Travassos' key, is characterised by having four uteri and very unequal and dissimilar

spicules. According to Seurat (1917 *a*), who has studied *Ph. leptosoma*, this species has only two uteri, so that again it appears that Travassos has made a new genus on wrong data. At any rate the name *Leptosoma* is not available, as according to Scudder (1882) it has already been used by Leach (1819) for a beetle, by Risso (1826) for a crustacean, by Nardo (1827) for a fish, and by Boisd. (1833) for a lepidopteran, while the form *Leptosomus* was used by Vieill. (1816) for a bird, and by Schönh. (1826) for a coleopteran.

With regards to the genera *Thubuncea* Seurat, 1914, *Heliconema* Trav., 1919, and *Proleptus* Duj., 1845, it does not appear necessary to discuss them here, as they do not affect the status of the genus *Physaloptera*.

Seurat (1915-16) has also proposed dividing the genus into four groups according to the teeth. These groups he characterises briefly as follows:—

1st group of *Ph. galinieri* Seurat.

The internal median tooth tripartite and very large, passing over the small external tooth.

2nd group of *Ph. clausa* Rud.

The external and median teeth are of the same height.

3rd group of *Ph. alata* Rud.

The external tooth is very large and triangular; the internal tooth (tripartite) is small.

4th group of *Ph. abbreviata* Rud.

The external tooth is enormous and triangular; the internal tooth is very small and difficult to see.

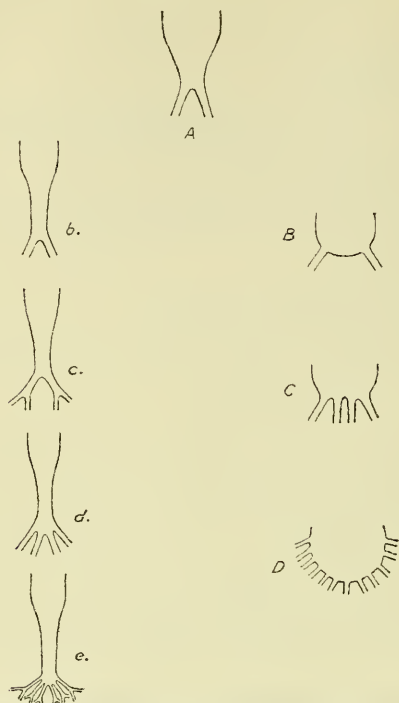
If we adopt this division, we would be obliged to add a 5th group of *Ph. colubri* (Rud.), Dies., characterised by the presence of a large and triangular external tooth and the entire absence of the internal median tooth.

In subdividing any group of animals, our first aim is to bring together those forms which possess close affinities to each other, and not those forms which, when grouped together, render it easier or more convenient to us to determine them. Seurat's divisions, when submitted to this test, are consequently not tenable, as it would imply that all the polydelphoid forms are closely related to such didelphoid forms as *Ph. preputialis* and *Ph. maxillaris*.

Assuming that the line of evolution has proceeded from the didelphic to the polydelphic forms, then, I think, we have to recognise two ways, both starting from a form with genitalia of the *Ph. clausa* (text-fig. 1 A) type. The one group would evolve from this type through stages like *Ph. preputialis* (text-fig. 1 B), *Ph. tumefaciens* (text-fig. 1 C) to *Ph. turgida* (text-fig. 1 D), and

the other along such stages as *Ph. obtusissima* (text-fig. 1 *b*), *Ph. abbreviata* (text-fig. 1 *c*), *Ph. paradoxa* (text-fig. 1 *d*) to *Ph. capensis* (text-fig. 1 *e*).

Text-figure 1.



Schematic representation of the probable methods of Uterine evolution from the didelphoid to the polydelphoid conditions.

A = *Ph. clausa* type; B = *Ph. præputialis* type; C = *Ph. tumefaciens* type;
D = *Ph. turgida* type; b = *Ph. obtusissima* type; c = *Ph. abbreviata* type;
d = *Ph. paradoxa* type; e = *Ph. capensis* type.

For the specific determination of the material examined, the following characters were especially noted:—

1. Number of uteri and their mode of origin.
2. Number and arrangement of the male caudal papillæ.
3. Relative lengths and shape of the spicules.
4. Number, shape, and size of the labial teeth.
5. Cuticular markings on the ventral surface of the male bursa.
6. Position of the vulva.

7. Presence or absence of a cuticular sheath at the posterior extremity.
8. Size of the eggs.
9. Relative length of the œsophagus.
10. Positions of the excretory pore and cervical papillæ.

The value attaching to each of these characters is indicated by its position in the above list.

SYSTEMATIC SECTION.

The remainder of the paper is divided into two parts. Part I. contains the descriptions and diagrams of all the species personally studied. Part II. gives an extract of the principal characteristics of all the species not personally examined. In most cases these extracts are based on the original descriptions and drawings; where this is not the case, the source is recorded under the species concerned. In each part the parasites are classified into three groups according to whether they were di-, tetra-, or polydelphoid, the arrangement proceeding from Mammals to Birds and to Reptiles.

Ph. acuticauda, however, has been placed together with *Ph. preputialis* and *Ph. malayensis* after the reptilian didelphoid forms, because of the similarity of their female genitalia. Species Inquirendæ, and species which were described as belonging to the genus *Physaloptera* but which have since been found to have been misplaced, are listed at the end of Part II.

The hosts cited after the species in Part I. are the hosts from which the material examined was collected; the hosts in Part II. are those from which the material collected formed the basis of the descriptions. A more detailed list of hosts from which the separate species have been recorded is furnished by Stiles and Hassall's 'Index Catalogue of Round-worms' (1920).

PART I.

Generic Diagnosis (emended).

Superfamily SPIRUROIDEA.

Family PHYSALOPTERIDÆ.

Subfamily PHYSALOPTERINÆ.

Mouth with two large simple and lateral lips, each armed with a variable number of teeth and carrying two external papillæ. Œsophagus consists of an anterior muscular and a posterior glandular part. Cuticle generally reflected over the lips. Caudal extremity of male with lateral alæ joining each other across the ventral surface in front of the anus. At least four pairs of pedunculated papillæ supporting the alæ; these generally arranged circumlocally. A variable number of ventral caudal papillæ,

generally three pre-anal and five pairs post-anal. Spicules unequal, subequal, or equal. Vulva in anterior half of body. Two, four, or many uteri. Eggs oval, smooth, thick-shelled, and embryonated when laid.

Parasitic normally in the digestive tract, generally the stomach, of mammals, birds, and reptiles, but very rarely in amphibians.

Type-species, *Ph. clausa* Rud., 1819.

GROUP *Didelphys*.

(1) *PHYSALOPTERA CLAUSA* Rudolphi, 1819. (Text-figs. 2-4.)

Syn. *Spiroptera clausa* (Rud.), Duj., 1845.

The material examined consisted of many specimens from *Erinaceus europæus* in the Vienna Museum (bottles 4447 & 4450), also some specimens from the same host in the collection of Prof. R. T. Leiper. The three lots of material were in all respects identical.

The cuticle appears smooth, but under high magnification a very delicate transverse striation is seen; it is only very slightly reflected over the base of the lips.

The cervical papillæ are lodged in small depressions of the cuticle, and are situated from 115 to 165 μ behind the level of the hind end of the muscular œsophagus; the excretory duct opens in the ventral mid-line at the same level as the cervical papillæ or just behind them.

The lips are almost semicircular in lateral view, but appear square in dorsal or ventral view. Each bears a medium-sized conical outer tooth with obtuse tip, and just internal to it a median tooth of equal height with three tips to its free end. No lateral teeth are present. The subdorsal and subventral external papillæ are small and dome-like.

The œsophagus immediately follows the lips; it is straight, and forms in the female 1/7·8 to 1/9th, and in the males 1/5·4 to 1/5·6 of the total body-length. Its muscular part is distinctly set off from the glandular, and is also slightly thinner; in the females it forms about 1/8·5, and in the males 1/7th of the whole organ. The nerve ring encircles it in its posterior quarter.

Female.

Mature females vary in length from 30 to 50 mm., with a maximum thickness of 1·3 to 1·6 mm. The body is attenuated in its anterior 1/3rd and posterior 1/5th; it is terminated by a bluntly conical tail 1/45th to 1/55th of the total body-length, with caudal pores in its posterior half.

The position of the vulva divides the body in the ratio of 1:1·7 to 1:2; it is situated on a slight elevation, and leads into a bent vagina 1·6 mm. long by 95 μ broad; the egg-chamber is slightly shorter but thicker, measuring 1·3 mm. long by 325 μ broad. From its posterior end the uteri, of which there are two,

directly take their origin, so that a common trunk portion is absent.

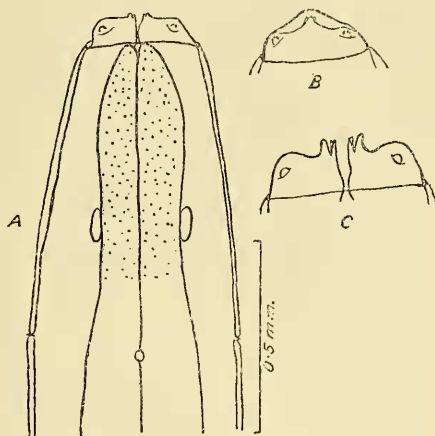
The eggs are oval and thick-shelled, measuring 52μ long by 38μ broad.

Male.

The males varied in length from 15 to 28 mm., with a breadth of 825 to 875μ . The body is attenuated only on its anterior half.

The caudal bursa is large, forming about 1/11th of the total length; it is bluntly rounded posteriorly, and is closely coiled ventralwards. The lateral expansions are well developed, and

Text-figure 2.



Physaloptera clausa Rud.

A = Anterior extremity of body.

B = Externo-lateral view of lip.

C = Ventral view of lip.

the four pairs of pedunculated papillæ supporting them are equidistant, two pairs being pre-anal and two pairs post-anal. There are 13 ventral papillæ, of which three are pre-anal and the rest post-anal. The pre-anal papillæ are situated in a row immediately anterior to the anus, the middle papilla being larger than the other two. The first two pairs of post-anal ventral papillæ are small and situated in a row just behind the anus; the remaining papillæ are equidistant and large, and they divide the tail into quarters; in some cases the last two pairs may be slightly approximated to each other.

The left spicule is nearly half as long again as the right, and is also much slenderer; it is 740μ long by 33μ broad at

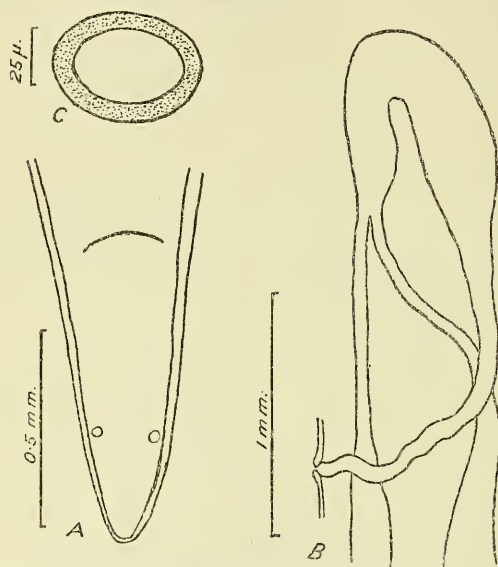
its base and tapers to a fine point; the right spicule is stout, $495\ \mu$ long and $50\ \mu$ broad at its base, and also terminates in a fine point.

Host: *Erinaceus europæus*. Stomach. Europe.

Types in bottle 4447 in the Vienna Museum.

My observations on this species differ in many respects from those of Seurat (1917 *b*) made on worms obtained from *Erinaceus algirus* and *Erinaceus deserti*. These differences apply more especially to the male. Seurat finds that of the three pre-anal ventral caudal papillæ the two lateral ones are far removed from

Text-figure 3.



Physaloptera clausa Rud.

A = Caudal extremity of female.

B = Terminal parts of female genitalia.

C = Egg-shell.

the median papilla and are also stalked; in my material these three papillæ are situated close together in a line immediately in front of the anus, and the lateral papillæ are non-pedunculate; also the median papilla is large and nearly twice the size of the other two, whereas Seurat finds this papilla to be very small.

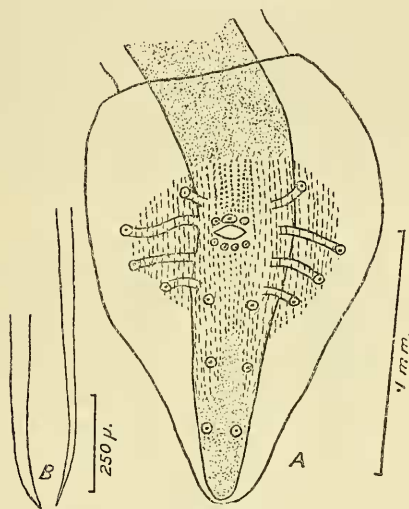
With regard to the post-anal ventral papillæ, the third pair is stalked in Seurat's material and sessile in mine.

Further, the spicules of his specimens differ from those of mine both in length and in shape; in his material the right and

left spicules are respectively 300 and 360 μ long, and only the left has a pointed tip. In my material the spicular lengths are as follows: right 495 μ , left 740 μ , *i. e.* the right is more than half as long again and the left twice as long. Both of them terminate in sharp points.

These, besides other minor differences, *e. g.* size of egg, length of ovijector, position of the vulva, etc., seem to indicate that the specimens studied by me belong to different species; and as I examined what I take to be the type-material, I think Seurat's specimens must be regarded as a new species, which, however, is very closely allied to *Ph. clausa*, as shown by the nature of the teeth and mode of origin of the two uteri.

Text-figure 4.

*Physaloptera clausa* Rud.

A = Caudal extremity of male. B = Spicules.

Schneider (1866) states that the inner teeth are smaller than the outer, and figures a male bursa having the papillæ arranged very similarly to those figured by Seurat; he does not definitely state that he has examined the Vienna material, although he quotes the same host from both Vienna and Berlin; it is probable that he examined material only from the latter locality, and that would partly account for the differences between his and my observations; it is therefore probable that he also is not dealing with *Ph. clausa*, but with a species identical with or very closely allied to that described by Seurat. Unfortunately Schneider's description is very brief, so that I am not able to make a closer comparison between his and Seurat's accounts.

(2) *PHYSALOPTERA PAPILLOTRUNCATA* Molin, 1860. (Text-fig. 5.)

The material examined consisted of the types of the species deposited in the Vienna Museum; this material had also been examined by von Drasche.

The cuticle is very finely striated transversely, and in the specimens examined it was not reflected over the lips; a coarse ringing is present in some specimens, probably due to some shrinkage.

The cervical papillæ are situated from 150 to 250 μ behind the level of the posterior margin of the muscular œsophagus, and the excretory duct opens to the exterior either at the same level or about 75 μ further back.

The lips are hemispherical in lateral view, and each has only two teeth, namely a large and blunt outer tooth recurved outwards, and a smaller tripartite inner tooth. Each lip bears on its subdorsal and subventral outer surface a dome-like papilla.

The œsophagus is straight, and forms in the females from 1/5.6 to 1/7th, and in the males 1/5th of the total body-length. Its muscular part is slightly thinner than the following glandular part, and forms from 1/8.6 to 1/10th of the whole organ; it is encircled by the nerve ring at the junction of its fourth and last fifths.

Female.

The females examined varied in length from 32 to 68 mm., with a maximum breadth of from 1 to 2.1 mm. The body is much attenuated in its anterior half, and slightly less so in its posterior quarter, where the body is terminated by a short and truncated tail 1/66th to 1/80th of the total body-length; its caudal pores are situated just behind its middle.

The vulva opens on a slight elevation, and is situated relatively far back; it divides the body in the ratio of 1:1.8 to 1:1.2; it leads into a slightly curved and muscular vagina 1.5 mm. long by 96 μ broad; this passes into the egg-chamber, which is 1.3 mm. long by 210 μ broad. The trunk which follows is of the same length and breadth as the vagina; from its posterior end there arise the two uteri which at first pass forwards, but soon recurve and pass down the length of the body.

The eggs are oval and thick-shelled, measuring on the average 52 μ long by 30 μ broad.

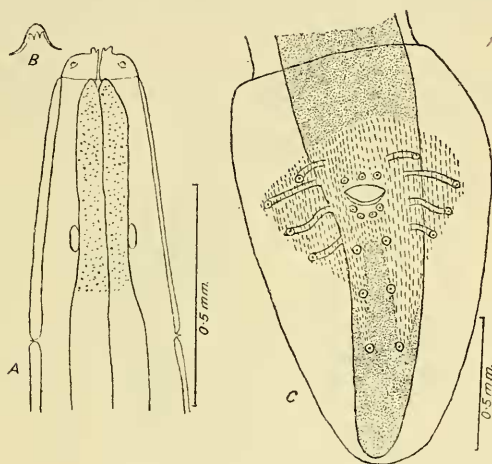
Male.

The males are much smaller than the females, and are attenuated in their anterior third, the rest of the body being of about the same thickness; they vary in length from 20 to 25 mm. with a breadth of 750 to 800 μ .

The bursa is large, and forms about 1/10th of the body-length; it has well-developed cuticular expansions, and is rounded at its tip. The ventral surface is traversed by longitudinal rows of protuberances. The four pairs of stalked papillæ are equidistant

from each other, the first, however, being more ventral in origin; two pairs are pre-anal, and the other two pairs are post-anal in position. The three pre-anal ventral papillæ are situated in a row immediately in front of the anus. There are five pairs of post-anal papillæ, of which pairs 1 and 2 are small and situated close together immediately behind the anus, one pair being slightly more posterior than the other; pairs 3, 4, and 5 are equidistant from each other; the distance between the 2nd and 3rd pairs is about half that between the 3rd and 4th pairs, and the distance between the 5th pair and the tip of the tail is about twice that between the 4th and 5th pairs.

Text-figure 5.

*Physaloptera papillotruncata* Mol.

A = Cephalic extremity of body.

B = Inner view of median labial teeth.

C = Caudal extremity of male.

The spicules are equal and straight; the right spicule is slightly slenderer than the left, and ends in a sharp point; the end of the left spicule is slightly flattened out to form a small spear-head; they are $360\ \mu$ long by 35 and $38\ \mu$ thick at their base respectively.

Host: *Myrmecophaga jubata*. Stomach. Brazil.

Types in bottle 4477 in the Vienna Museum.

Discussion.—See *Ph. maxillaris*.

(3) PHYSALOPTERA SEMILANCEOLATA Molin, 1860. (Text-fig. 6.)

The material examined was somewhat shrunken, but in excellent preservation.

The cuticle is finely striated, and shows, in addition, an

irregular course ringing, probably due to contraction; in some cases it is completely reflected over the lips, and in others only the base of the lips are covered.

The cervical papillæ are situated about $300\ \mu$ behind the level of the hind end of the muscular œsophagus, and the excretory duct opens about $90\ \mu$ further back.

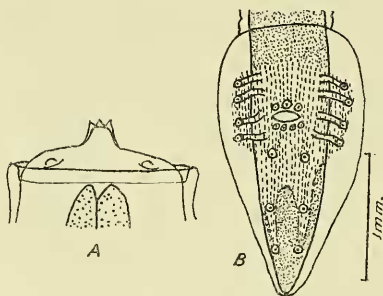
In the specimens examined the œsophagus was thrown into loops, so that a correct estimation of its length could not be determined; roughly, it forms in the male about $1/5$ th, and in the female about $1/6$ th of the total length.

The lips are flatly rounded, and each bears two large terminal teeth of the same height; the outer tooth is markedly truncated, whereas the inner is foliaceous and tripartite. Each lip has on its outer surface a prominent subdorsal and subventral papilla.

Female.

The females are coiled, and mature specimens average in length from 21 to 37 mm. long by $\cdot 9$ to $1\cdot 5$ mm. thick. The body is of

Text-figure 6.



Physaloptera semilanceolata Mol.

A = Externo-lateral view of head.

B = Caudal extremity of male.

a more or less uniform thickness throughout, except for the anterior $1/10$ th and posterior few millimetres. The tail in all specimens examined was bent dorsalwards. It tapers only slightly towards its tip, which is very bluntly rounded; the caudal pores open in its posterior $1/5$ th.

The vulva opens very far forwards, in some specimens its position being just anterior to the hind end of the œsophagus and in others just behind it. It leads into a long and coiled vagina about 3 mm. long by $110\ \mu$ broad; its posterior end gradually widens to join the swollen egg-chamber, which, when distended with eggs, measured $2\cdot 75$ mm. long by $440\ \mu$ broad. The common trunk is relatively short and slightly thinner than the vagina; it measured about $475\ \mu$ long by $95\ \mu$ thick. The two uteri which arise from it may first pass forwards, and then recurve to pass down the length of the body.

The eggs are oval and thick-shelled, and are already embryonated *in utero*; they are 50μ long by 32μ broad.

Male.

The males are also coiled, and the body is attenuated in its anterior third. The specimens examined measured from 25 to 32 mm. long by 750 to 875μ thick. The bursa is relatively narrow and pointed, and three of the four pairs of pedunculated papillæ are pre-anal in position. The three pre-anal ventral papillæ are equidistant from the cloaca, and the central papilla is slightly larger. There are five pairs of post-anal ventral papillæ, of which the first two pairs are small and situated in a row immediately behind the anus; the third pair is at the junction of the 1st and 2nd sixths of the tail, the fourth at about the middle, and the last at the junction of the 3rd and last quarters of the tail. The ventral surface is covered with longitudinal rows of irregular tubercles.

The spicules are slightly unequal, of the same thickness, and slightly curved; both taper to fine points; the right is 574μ long by 38μ thick at its base, the left is 730μ long by 38μ at its base.

Host: *Nasua narica*. Stomach. Brazil.

Discussion.—The small pair of papillæ between the 4th and 5th pairs of ventral post-anal papillæ described by von Drasche are the openings of the caudal pores.

Affinities.—See *Ph. maxillaris*.

(4) PHYSALOPTERA MAXILLARIS Molin, 1860. (Text-fig. 7.)

The material examined consisted of the types of this species deposited in bottle 4458 in the Vienna Museum; the material was in an excellent state of preservation.

The cuticle is finely striated transversely, and is partly or wholly reflected over the lips. The cervical papillæ are situated half a millimetre behind the junction of the two œsophageal parts, and the excretory pore about 50μ further back.

The lips are rounded or slightly conical; each has two terminal teeth—namely, a large triangular outer tooth with obtuse tip slightly bent outwards, and an inner semi-membranous tooth, tripartite at its free end, and of the same size as the outer tooth. Two large conical papillæ are present on the outer surface of each lip.

The œsophagus is straight, and thickens gradually towards its posterior end; in the female it forms $1/5.2$ to $1/5.4$, and in the male $1/6$ th to $1/6.4$ of the body-length; its anterior tenth forms the muscular part, which is slightly thinner than the glandular, and is encircled by the nerve cord in its posterior third.

Female.

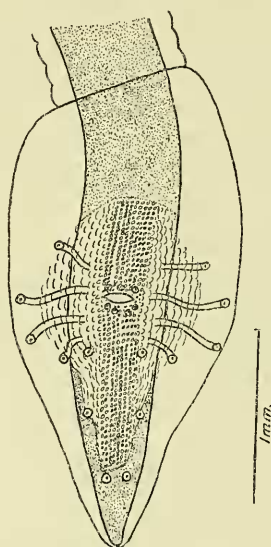
The females are stout, and are attenuated only in their anterior third and tail region; this latter part tapers abruptly to form a short and pointed tail $1/73$ rd of the body-length, and having its caudal pores situated in its middle. Mature forms vary in

length from 20 to 36 mm., with a maximum breadth of $800\ \mu$ to $1.24\ \text{mm}$.

The vulva is slightly protuberant, and its position divides the body into the ratio of 1:1.6. The vagina is long, and varies in length from $2\frac{1}{4}$ to $3\frac{1}{4}$ mm. with a thickness of $95\ \mu$. The egg-chamber is elongately oval, and is 1.7 mm. long by $435\ \mu$ in diameter. The common trunk is short, and varies in length from 290 to $320\ \mu$; it is slightly thicker than the vagina; from its posterior end the two uteri take their origin, and may either pass forwards and then bend backwards, or else pass posteriorly directly.

The eggs are oval and thick-shelled, and measure $43\ \mu$ long by $31\ \mu$ broad.

Text-figure 7.



Physaloptera maxillaris Mol.

Caudal extremity of male.

Male.

The males are much attenuated from behind forwards, having their maximum thickness just above the bursa; they vary in length from 23 to 32 mm., with a thickness of 550 to $800\ \mu$.

The bursa is elongated and somewhat pointed, and has its caudal expansions well developed in its middle portion. Its ventral surface is ornamented by two types of cuticular bosses, those in the central area, above and below the anus, being rounded, simulating those found in *Ph. praeputialis*, while those on the lateral areas are in the form of much-broken ridges; the transition from the one type to the other is gradual.

The four circumcloacal lateral papillæ are provided with very long stalks, especially the 2nd and 3rd pairs. The ventral papillæ in the immediate vicinity of the anus are small, and consist of three pre-anal papillæ in a row, and two pairs post-anal, also in a row. Further down the tail there are three additional pairs; these are equidistant from each other, the most anterior being situated just behind the level of the last pair of stalked papillæ.

The spicules are slightly bent, unequal, and the right is stouter than the left; both taper to sharp points. The left is 1.2 mm. long by 40μ thick at its base, and the right is 560μ long by 57μ thick at its base.

Host: *Mephites chinche*. Stomach. Brazil.

Types in bottle 4458 in the Vienna Museum.

Some specimens of this species, collected from *Mephites mephitica*, were handed over to me for identification by Mr. R. I. Pocock, F.R.S.; he obtained them from animals introduced into Northumberland (England) from Canada, but how long they had been in England before the parasites were collected it was not possible to definitely find out. I wish to express my thanks to Mr. Pocock for this material.

This material differs from the types studied in that they are slightly larger, and the bursa of the male appears rounded and lobulated; however, I believe these characters of the bursa to be due to shrinkage, as the worms had been killed in formalin.

Solanet in 1909 described another species—*Ph. mephites*—from *Mephites suffocans*, Buenos Aires. Unfortunately I have not been able to consult his description, and consequently cannot discuss the relation of this species to *Ph. maxillaris*.

The arrangement of the ventral bursal papillæ, the presence of two uteri, general characters of the teeth, ally this species to *Ph. semilanceolata*, *Ph. clausa*, and *Ph. papillotruncata*. *Ph. semilanceolata* differs from it by its truncated outer tooth, more anterior position of the vulva, shorter left spicule, and type of ornamentation on the bursa. It differs from *Ph. papillotruncata* by its longer and pointed spicules, ornamentation on the bursa, and smaller size of the adult females. *Ph. clausa* is distinguished from it by the size of the spicules, markings on the bursa, and absence of a common trunk to the unpaired female genitalia.

(5) PHYSALOPTERA ANOMALA Molin, 1860. (Text-fig. 8.)

The material examined consisted of three males and one female; type-material in bottle 4446 in the Vienna Museum. The material was in excellent preservation.

The cuticle is finely striated transversely, and is partly reflected over the base of the lips; the cervical papillæ pierce it on either side from 320 to 400μ behind the level of the posterior end of the muscular œsophagus; the excretory pore is found about 100μ further back.

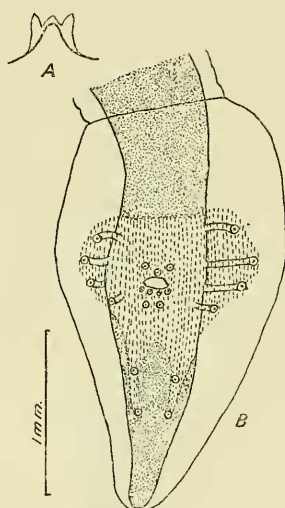
The lips are large and conical, and each carries a large conical but blunt tooth; the inner tooth is large and of equal height, with its free end divided into three points, of which the middle one is slightly shorter than the other two. No lateral teeth are present. Externally each lip carries a subdorsal and subventral conical papilla.

The œsophagus has its anterior muscular part thinner than the rest, and the nerve ring encircles this part in its posterior quarter. The œsophagus forms in the male about $1/5.4$, and in the female $1/5.6$ of the total body-length.

Female.

The solitary female was 36 mm. long and just under 2 mm.

Text-figure 8.



Physaloptera anomala Mol.

A = Outer view of median teeth.

B = Caudal extremity of male.

broad in its middle; the body is much attenuated in the anterior half, but only slightly so posteriorly; it is terminated by a bluntly-pointed tail, $1/60$ th of the body-length, and having the caudal pores in its posterior half.

The vulva is situated just behind the end of the œsophagus, and divides the body in the ratio of $1:4.2$; it leads into a coiled vagina 1.9 mm. long by 95μ thick; this joins with a large and spacious egg-chamber 2 mm. long by 560μ broad, which posteriorly narrows suddenly to join the 400μ long common trunk, which is of the same thickness as the vagina. The posterior end

of the trunk divides into two branches, each of which connects up with one of the two uteri.

The eggs are thick-shelled and oval, measuring 38μ long by 26μ broad.

Male.

The males are from 30 to 32 mm. long by 1 to 1.2 mm. broad; they are attenuated towards both extremities and the bursa is slightly incurved.

The caudal bursa is large, and is covered ventrally by longitudinal rows of cuticular elevations. The four pairs of pedunculated papillæ are situated three pairs pre-anal and a pair post-anal. Of the three pre-anal ventral papillæ the middle one is nearer the anus. There are five pairs of post-anal papillæ, of which the pairs 1 and 2 are small, and situated in a row immediately behind the anus. Pairs 4 and 5 are large, and are situated in the middle area of the tail. The distance between the 3rd and 4th pairs is about four times the distance between the 2nd and 3rd pairs, and twice that between the 4th and 5th pairs.

The spicules are short and equal, each measuring 495μ long by 32μ broad at their base; they are straight, tubular, and pointed.

Host: *Felis onca*. Stomach. Brazil.

Types in bottle 4446 in the Vienna Museum.

(6) PHYSALOPTERA MURIS-BRASILIIENSIS Diesing, 1861. (Text-fig. 9.)

Syn. *Spiroptera bilabiata* Mol., 1860 (not *Spiroptera bilabiata* (Crep., 1829), Duj., 1845).

The material studied consisted of ten females in bottle 4525 and two males in bottle 4524 in the Vienna Museum. This material constituted the types of this species.

The cuticle forms a ring round the base of the head, but leaves the lips naked; it is very finely striated transversely. The cervical papillæ are situated about 250μ behind the level of the hind end of the muscular œsophagus, and the excretory pore is situated about 100μ further back.

The lips are large, and each bears two large outer papillæ. The external tooth is small, and the inner is of the same size, foliaceous, and tripartite; no additional teeth were observed.

The muscular œsophagus is markedly thinner than the rest of the organ, and forms a little less than 1/10th of its whole length. The nerve ring encircles it in its posterior 1/4th. The œsophagus forms in the female about 1/8th and in the male about 1/6th of the total body-length.

Female.

The length of the female varies from 35 to 43 mm., with a maximum breadth of 1.1 to 1.75 mm.

The body is attenuated in its anterior third, but posteriorly has a more or less uniform thickness; it is terminated by a short and obtusely rounded tail, forming about 1/100th of the total body-length.

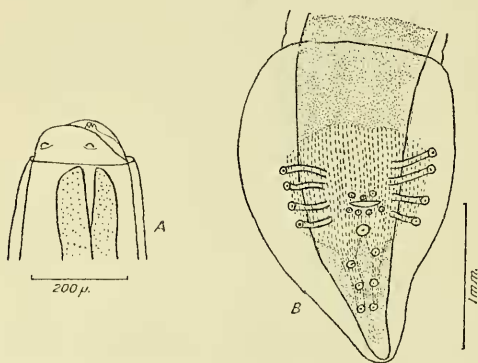
The vulva is slightly protuberant, and is situated at about the junction of the first and second quarters of the body. It leads into a coiled vagina 2 mm. long by 80μ thick; the egg-chamber is about 800μ long by 300μ thick and the common trunk about 640μ long by 112μ broad; its posterior end divides into two to give rise to the two uteri.

The eggs are oval and thick-shelled, measuring 45μ by 26μ broad, and are fully embryonated *in utero*.

Male.

The two males were respectively 22 and 28 mm. long, with a thickness of 870 and 950μ . They are attenuated in their anterior half and the posterior end is curved ventralwards,

Text-figure 9.



Physaloptera muris-brasiliensis Dies.

A = Anterior extremity of male.

B = Caudal extremity of male.

The bursa is somewhat heart-shaped with a drawn-out tip, the lateral expansions being much better developed in their anterior half. Of the four pairs of pedunculated papillae three pairs are pre-anal. There are six pairs of ventral paired papillae and two unpaired papillae; of these one pair and an unpaired papilla are pre-anal, the latter being nearer the anus. The first and second pairs of post-anal papillae are small and are situated in a row immediately behind the anus; pairs 3, 4, and 5 are equidistant from each other, and are situated respectively at the 2nd, 3rd, and 4th sixths of the tail; they are all larger than the first two pairs. The unpaired post-anal papilla is about midway between the 2nd and 3rd pairs, and is about twice as large as the latter.

The spicules are equal, straight, and pointed, each measuring $400\ \mu$ long by $32\ \mu$ broad.

Host: *Mus brasiliensis*. Stomach and small intestine. Brazil.

Type males in bottle 4524, type females in bottle 4525, both in the Vienna Museum.

Von Drasche, in his account of this species, considers that the number and arrangement of the bursal papillæ may be somewhat different, as the material he worked with was too opaque. By clearing the specimens in beechwood creosote, I was able to make out two additional pairs of ventral post-anal papillæ, viz. pairs 2 and 4, as well as the nature and lengths of the spicules.

(7) PHYSALOPTERA ALATA Rudolphi, 1819. (Text-fig. 10.)

Syn. *Spiroptera physalura* Duj., 1845.

The material examined consisted of some males and females from *Falco gallicus* and some females from *Falco pennatus*; both lots from the Vienna Museum.

These parasites have a somewhat slender body, whose cuticle is very finely striated transversely; the cuticle is either completely reflected over the lips or else leaves them quite naked.

The cervical papillæ are found from 75 to $100\ \mu$ behind the level of the hind end of the muscular œsophagus. The position of the excretory pore appears to vary in that it was found in some specimens to be very slightly posterior to the cervical papillæ, whereas in others it was as much as $200\ \mu$ further back.

The lips are somewhat spherical in lateral view, and each carries two terminal teeth; the inner median tooth consists of three large denticles, and is larger than the outer tooth; the outer tooth varies in size: in some specimens it is very small, whereas in others it is almost as large as the inner tooth; a series of sizes can, however, be traced in different specimens, showing the transitions of the smaller to the larger sized outer teeth. Two somewhat slender external papillæ are present on each lip.

The œsophagus is straight, and forms in the males about $1/6$ th and in the female $1/5.3$ to $1/6.6$ of the body-length. Its muscular part is thinner than the glandular, and is encircled by the nerve ring in its posterior quarter; it forms about $1/9$ th of the whole organ.

Female.

The females from *F. gallicus* were all immature except one, and this specimen was 21 mm. long and $540\ \mu$ thick; those from *F. pennatus* were about 30 mm. long and $700\ \mu$ thick, and were all mature; the body is attenuated in its anterior half and also slightly in its posterior third; in the immature forms the tail forms about $1/45$ th of the body-length, but in the mature forms it is slightly longer.

The vulva opens practically level with the general surface, and is situated relatively far back; its position varies slightly,

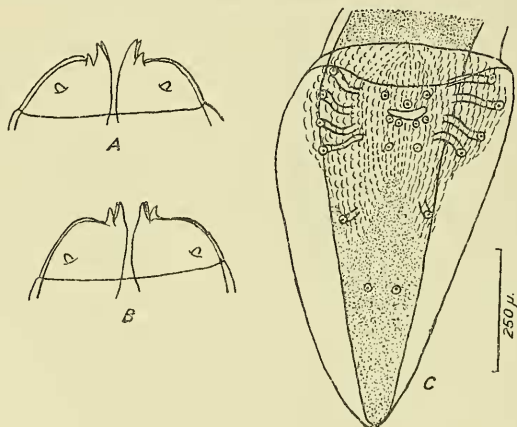
dividing the body into the ratio of 1 : 1.07 to 1 : 1.4. The vagina is straight, and may either pass forwards or backwards; it is muscular, about $1\frac{1}{4}$ mm. long and 60μ thick. The egg-chamber may pass forwards with the vagina or be bent backwards; it is about half the length of the vagina, and its breadth varies according to whether it is distended with eggs or not. The common trunk is short, and is nearly 300μ long; its posterior end divides into two to give rise to the two uteri.

The eggs are thick-shelled and oval, measuring on the average 41μ long and 23μ in diameter.

Male.

The two males are respectively 17 and 18 mm. long, and are .5 mm. thick in their posterior third. The body is much attenuated in its anterior half.

Text-figure 1C.



Physaloptera alata Rud.

A & B = Ventral view of lips, showing variations in size of the external tooth.

C = Caudal extremity of male.

The bursa is relatively narrow and lanceolate in shape. There are five pairs of pedunculated lateral papillae, of which two pairs are pre-anal and the rest post-anal in position; the anterior four pairs are equidistant from each other, whereas the distance separating the 4th and 5th pairs is about three times that separating the other pairs; this last pair is also more ventral in origin than the others. There are five pairs and an unpaired ventral papillae; one pair and the unpaired papilla are situated in a triangle in front of the anus, the remaining four pairs being post-anal. The 1st and 2nd post-anal pairs are small, and are found on the posterior margin of the anus; the 3rd pair is situated just behind the level of the 4th pair of stalked papillae;

the 4th pair is at the middle of the tail, and it divides the distance from the last pair of pedunculated papillæ to the tip of the tail in about the ratio of 1 : 2.

The ventral surface of the bursa is ornamented with longitudinal rows of tubercles extending slightly posterior to the last pair of stalked papillæ.

The spicules are short, equal, and pointed; the right, however, has a slightly stouter base; they are 275μ long, the left spicule being 25 and the right 30μ thick at its base.

Hosts: *Falco gallicus*. Intestine. Museum, Vienna; bottle 4439.

Falco pennatus. Stomach. Museum, Vienna; bottle 4442.

Discussion.—This material differs from Schneider's (1866), von Linstow's (1877), and Seurat's (1914*e*) descriptions of this species in the nature of the teeth and in the arrangement of the male bursal papillæ; these two characters are in keeping with *Ph. subalata* Schn., 1866, and *Ph. galinieri* Seurat, 1914. As the specimens examined consisted of the paratypes of *Ph. alata*, it appears to me that the conception of the species has been erroneous. Further, it would appear that Seurat's species *Ph. galinieri* is either a synonym or a variety of *Ph. alata*, because it agrees with Rudolphi's species in the nature of the teeth, the arrangement of the male bursal papillæ, the very posterior position of the vulva, and the anterior direction of the vagina; it differs from *Ph. alata* in its relatively shorter œsophagus and in its slightly longer and subequal spicules.

Rudolphi described this species from three hosts in the Vienna Museum, viz. *Falco nisus*, *F. pennatus*, and *F. gallicus*. I take his specimens from the first-named host to be the types of this species, and the material from the other two hosts to be the paratypes.

An extracted description of *Ph. galinieri* Seurat is included in Part II.

(8) PHYSALOPTERA RETUSA Rudolphi, 1819. (Text-figs. 11 & 12.)

Syn. *Spiroptera retusa* (Rud., 1819), Duj., 1845.

I have been able to examine two lots of material of this species, both having been collected from the Teguexin. The first lot consisted of specimens deposited in the Vienna Museum (bottle 4497), and the second I collected from a Teguexin which died in the Gardens of the London Zoological Society. Both sets of material were in all respects identical.

The cuticle is very finely striated transversely and, in addition, shows a coarse irregular ringing. Anteriorly it is partly or wholly reflected over the lips.

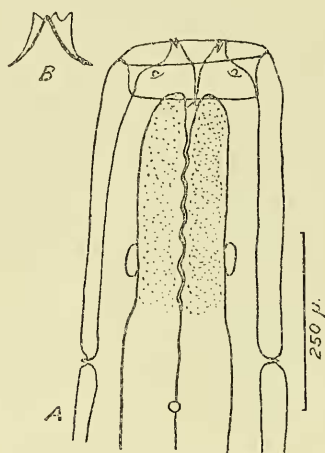
The cervical papillæ are inserted generally symmetrically on either side, but sometimes one may be slightly more anterior to the other; they are lodged a short distance behind the junction

of the two œsophageal parts. The excretory pore is situated about $50\ \mu$ further back.

The lips are large and somewhat triangular in side view, and each carries on its apex a large triangular tooth. Immediately internal to it there is a slightly larger but membranous tooth, whose free extremity is tripartite. No lateral teeth are present. Each lip bears on its outer surface two conspicuous papillæ.

The œsophagus is long, and in the female it is about $1/7$ th, in the male slightly more or slightly less than $1/5$ th of the body-length. Its anterior region is differentiated into a short muscular portion, about $400\ \mu$ long in fully-grown specimens and slightly thinner than the rest of the œsophagus; the large nerve ring encircles it in its posterior quarter.

Text-figure 11.



Physaloptera retusa Rud.

A = Ventral view of cephalic extremity.

B = External aspect of median teeth.

Female.

The largest female measured 45 mm. long, and 1.2 mm. broad in the middle; fully mature females varied in size from 20 mm. upwards. The body is rather robust, tapering only slightly towards both ends; the tail, however, is sharply set off from the body, and is relatively short and slender; it forms on an average $1/107$ th of the total body-length, and its caudal pores are situated in its posterior third.

The vulva opens on a level with the general surface, and is situated some distance behind the end of the œsophagus. Its position varies slightly in different individuals, but in general it is seen at the junction of the 1st and 2nd quarters of the body. It leads in the largest females into a relatively short and thick-

walled vagina, about 1.1 mm. long and $100\ \mu$ in diameter. The following egg-chamber is about $\frac{3}{4}$ ths of the length of the vagina and about twice as broad. The common trunk is very short, so that in some cases it appears to be absent; its posterior end divides into two branches, each of which connects up with one of the two uteri.

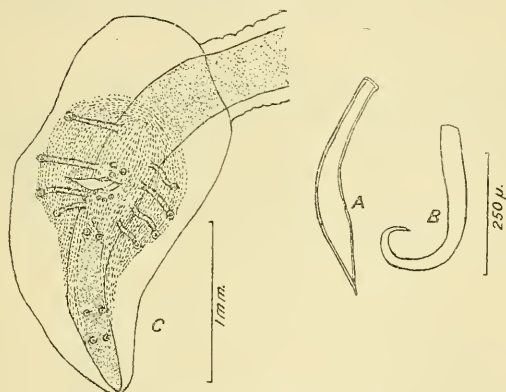
The receptacula seminis are slightly oval, $380\ \mu$ long by $280\ \mu$ broad; they are distinctly constricted off from the oviducts, but their junction with the uteri is very gradual.

The eggs, which on the average are $43\ \mu$ long and $27\ \mu$ in diameter, contain fully-developed embryos *in utero*; they are thick-shelled and oval.

Male.

The males are much smaller than the females, the longest measuring 20 mm. long and $570\ \mu$ broad. Anteriorly the body

Text-figure 12.



Physaloptera retusa Rud.

A = Left spicule. B = Right spicule.

C = Caudal extremity of male.

(The scale alongside B refers also to A.)

tapers very gradually, but posteriorly hardly any narrowing takes place until a very short distance in front of the bursa; here the thickness becomes sharply less, so that at the juncture of the bursa it is only about $\frac{3}{4}$ ths of the thickness further forwards.

The male bursa is large, measuring about 2.3 mm. long by 1.1 mm. broad in the largest specimens, and is sharply reflected ventralwards. The cuticular expansions are well developed, and the four pairs of pedunculated papillae supporting them are situated equidistant from each other, two pairs being pre-anal and two pairs post-anal. The ventral surface of the bursa is covered by numerous longitudinal rows of small protuberances.

There is one pair and an unpaired median ventral papillæ in front of the anus. These are so placed as to form a triangle with its apex directed towards the anus. Behind the anus there are five pairs of ventral papillæ, of which the first two pairs are situated immediately behind the anus. The third pair is placed at the junction of the 1st and 2nd quarters of the tail, whilst the 4th and 5th pairs are situated further back, and are slightly approximated. Equidistant from these last two pairs there is seen what appears to be a very small papilla, but which probably is the opening of the caudal glands.

The spicules are only very slightly unequal, the right spicule being the longer and more slender. Some difficulty was encountered in making out their lengths in cleared specimens because of their paleness, and consequently they were dissected out by means of a dissecting microscope. The left spicule broadens posteriorly to about $90\ \mu$ and then gradually tapers to a point; it is $455\ \mu$ long, and $32\ \mu$ broad at its base. The right spicule, which is $475\ \mu$ long, and $45\ \mu$ broad at its base, tapers gradually to a point, and in all the males examined its posterior extremity was recurved.

Host: *Tupinambis teguixin*. Stomach. Brazil.

In addition to the material described above, I have also examined a few specimens from the mouth of a Hog-nosed Snake (*Heterodon platyrhinnus*, S. America) which I have referred to the above species. They agree with *Ph. retusa* in practically all respects except in the size of the spicules, which in this material are equal in length and $300\ \mu$ long. Their shapes, however, are identical with those described above.

(9) PHYSALOPTERA MONODENS Molin, 1860. (Text-figs. 13 & 14.)

The material on which the study of this species is based was collected from *Boa constrictor* and deposited in bottle 4459 in the Vienna Museum.

The cuticle is finely striated and completely reflected over the lips. The cervical papillæ vary in their position, in some cases being at the level of the hind end of the muscular oesophagus, and in others as much as $300\ \mu$ further back. The excretory pore is situated about $400\ \mu$ behind the muscular oesophagus.

The lips are dome-shaped, and each bears a small subdorsal and subventral external papilla. The two median teeth are of unequal size, the inner one being much smaller; the outer tooth is sharply conical, the inner foliaceous and tripartite; they are rather small.

The muscular oesophagus forms about $1/10$ th of the whole organ, which is about $1/5\cdot3$ of the body-length in the male and $1/8$ th in the female. The nerve ring encircles its muscular portion in its posterior quarter.

Female.

Mature females vary in length from 25 to 40 mm., with a maximum thickness of 850 to 960 μ ; its greater portion is of more or less uniform thickness, tapering being confined only to the last few millimetres of the two extremities. The tail is obtuse, and forms about 1/75th of the body-length.

The vulva is protuberant, and its position divides the body into the ratio of 1 : 5. It leads into a slightly coiled vagina 1.6 mm. long by 65 μ thick. The following egg-chamber is relatively short and thin, being 640 μ long and 130 μ in diameter. The common trunk is very short, being only 160 μ long and as thick as the vagina; its posterior end divides once to give rise to the connections of the two uteri.

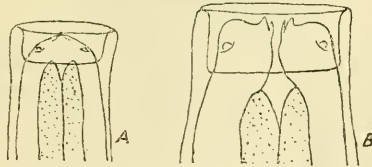
The receptacula seminis are oblong, 240 μ long and 175 μ in diameter.

The eggs are thick-shelled, oval, and embryonated *in utero*; they measure 45 by 26 μ .

Male.

In the males the body is attenuated only in its anterior third; the longer specimens varied from 18 to 23 mm. long by 710 to 770 μ thick.

Text-figure 13.

*Physaloptera monodens* Mol.

A = Cephalic extremity, lateral view.

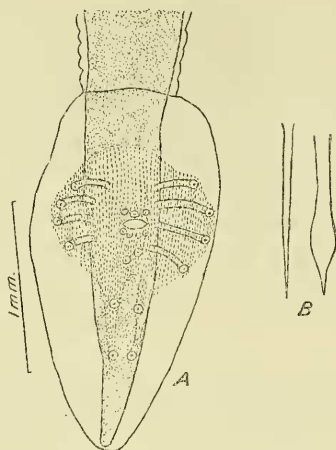
B = Cephalic extremity, ventral view.

The bursa is ovoid, has well-developed alæ, and its ventral surface shows longitudinal rows of small irregularly rounded tubercles. The three anterior pairs of stalked papillæ are pre-anal in position. Of the three pre-anal ventral papillæ the central one is the largest, and is situated closer to anus than the other two. There are five pairs of post-anal ventral papillæ, of which the first two pairs are small and situated in a row immediately behind the anus; the 3rd pair is slightly obliquely placed at about the junction of the 1st and 2nd sixths of the tail; the 4th pair is just in front of the middle of the tail. The distance separating the 4th from the 5th pair is slightly less than that between the 3rd and 4th pairs. The caudal pores

are conspicuous, and are found between the last two pairs of ventral papillæ.

The spicules are unequal, and the left has its end broadened out to form a kind of spear-head; it is 415μ long and 38μ broad at

Text-figure 14.



Physaloptera monodens Mol.

A = Caudal extremity of male.

B = Right and left spicules.

its base. The right spicule is shorter and thinner, and tapers to a fine point; it is 362μ long by 32μ broad at its base.

Host: *Boa constrictor*. Stomach and intestine. South America.

Types in bottle 4459 in the Vienna Museum.

For affinities see *Ph. obtusissima*.

(10) *PHYSALOPTERA OBTUSISSIMA* Molin, 1860. (Text-figure 15.)

The specimens of this species which were examined were deposited in bottles 4463 and 4470 in the Vienna Museum; in both cases the host was simply given as *Colubri*, N. 58.

The cuticle is slightly reflected over the base of the lips, and is provided with a fine transverse striation. The cervical papillæ pierce it from 130 to 225μ behind the level of the posterior end of the muscular cesophagus, and the excretory pore is situated about 100μ further back.

The lips are hemispherical in lateral view and slightly flattened. The external tooth is large and bluntly conical, and is slightly bent outwards; the inner tooth is membranous, tripartite, and of the same height as the outer. The two external lip papillæ are large.

The cesophagus is straight and short; in the female it forms

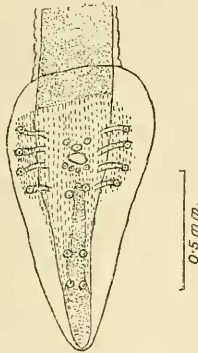
about $1/9$ th and in the male about $1/7$ th of the total body-length. Its muscular part is slightly thinner, and the nerve ring is situated in its last quarter.

Female.

The females are rather slender, mature worms varying from 28 to 47 mm. long by 650 to $720\ \mu$ thick in their posterior third. The body is much attenuated in its anterior half and in its posterior quarter. The tail is short and bluntly conical, and forms $1/80$ th of the body-length; its caudal pores are situated behind its middle, and their position divide the tail in the ratio of 3 : 2.

The vulva is situated on a slight elevation at the junction of the 1st and 2nd quarters of the body. It leads into a straight vagina 1.5 mm. long by $65\ \mu$ thick; the following egg-chamber is oblong and $640\ \mu$ long by $175\ \mu$ broad; the common trunk is

Text-figure 15.



Physaloptera obtusissima Mol.

Caudal extremity of male.

short, and half again as thick as the vagina; it is $320\ \mu$ long, and its posterior end divides to give rise to two branches, each of which joins up with a uterus. The proximal parts of the uteri may be much convoluted in some individuals; posteriorly each terminates in a receptaculum seminis, which is long and oval, measuring $400\ \mu$ long by $160\ \mu$ broad.

The eggs are fully embryonated *in utero*; they are oval and thick-shelled, and measure 45 by $26\ \mu$.

Male.

The males are comparatively stouter than the females; they vary in length from 20 to 32 mm., with a maximum thickness of 700 to $720\ \mu$. The body is attenuated only in its anterior third.

The caudal bursa is elongate and somewhat lanceolate in shape; its alæ are well developed and its ventral papillæ are

large. The stalked papillæ are equidistant, two pairs being pre-anal and two pairs post-anal. Of the three pre-anal ventral papillæ, the central one is large, and is situated nearer the rim of the anus than the other two. There are four post-anal sessile papillæ, of which the first two pairs are small and arranged in a row immediately behind the anus; the 3rd pair is slightly obliquely placed just behind the level of the last pair of stalked papillæ; the 4th pair is at about the middle, and the last pair at the junction of the 2nd and last thirds of the tail.

The spicules are short and slightly unequal; the right is $385\ \mu$ long by $38\ \mu$ broad at its base, and tapers to a fine point; the left is $430\ \mu$ long by $38\ \mu$ broad at its base; its posterior half broadens out to about $74\ \mu$ to form a comparatively large spear-head.

The ventral surface of the tail is traversed by longitudinal rows of irregular tubercles of the same size and shape as those found in *P. monodens*.

Host: *Colubri*, N. 58. Brazil.

This species appears to be closely allied to *Ph. monodens*, with which species it agrees in the arrangement of the caudal papillæ of the male, the general shape of the spicules, markings on the bursa, and size of the eggs. It differs from this species, however, in its larger teeth, more posterior position of the vulval aperture, shorter œsophagus and larger receptacula seminis.

Von Drasche (1883) states that the inner teeth are very small; my observations showed that they were in nearly all cases of the same size as the outer teeth, and could be easily seen from either lateral or ventral (dorsal) views of the lips.

(11) *PHYSALOPTERA BONNELI*, sp. n. (Text-figs. 16 & 17.)

The material consisted of four females and two males, collected from a "Sapakara," Dutch Guiana; the females varied in length from 41 to 50 mm., and the males are respectively 26 and 33 mm. long.

The cuticle is transversely striated, the striæ being about $\mu 4$ apart. In addition there is a very distinct and coarse ringing. It is only very slightly reflected over the base of the lips.

The cervical papillæ are situated some distance behind the junction of the two œsophageal parts, this distance being about half the length of the muscular œsophagus. The excretory duct opens to the exterior about $150\ \mu$ further back.

The lips are somewhat flattened, and each has two outer papillæ. Only two teeth are present on each lip, an outer and an inner median tooth. They are of the same size, the outer being conical and obtuse, whereas the inner is membranous and tripartite.

The muscular œsophagus is only slightly thinner than the glandular, and the nerve ring is situated at the junction of its

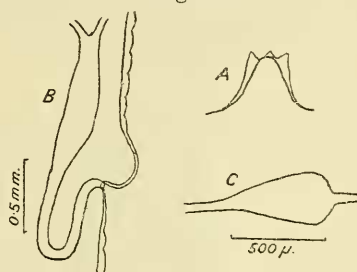
3rd and last quarters. The whole organ forms in the male $1/5.6$, in the female $1/7.6$ of the body-length.

Female.

The female is slightly attenuated towards both extremities, and is terminated posteriorly by a slender tail, forming $1/56$ th part of the body. Its caudal pores are situated at the junction of its 2nd and last thirds. The maximum breadth of the largest female is 1.3 mm. just behind its middle.

The vulva is situated in a depression partly overhung by an anterior cushion-like thickening of the body; it divides the body in the ratio 1 : 2.5. The vagina is coiled, and is 1.2 mm. long by 95μ thick; the following egg-chamber is about 1 mm. long and twice as broad as the vagina; its posterior end divides into two, and each branch joins up with a uterus, a common trunk being absent. The anterior half of the vagina, the egg-chamber, and the terminal portions of the uteri are directed forwards, the

Text-figure 16.



Physaloptera bonnei, sp. n.

A = Outer view of median teeth.

B = Terminal portion of female genitalia.

C = Receptaculum seminis.

uteri extending as far as the base of the œsophagus, when they bend sharply backwards and pass almost to the posterior end of the body. The receptacula seminis are pear-shaped, and are 480μ long by 265μ broad at their junction with the oviducts.

The eggs are elongate, oval, and thick-shelled, and contain fully-developed embryos; on the average they are 42μ long by 25μ broad.

Male.

The males are much thinner than the females, the diameters of the larger and smaller worms being respectively 950 and 850μ . The bursa is large, forming about $1/14$ th of the body-length, and is nearly twice as long as broad. Ventrally it is ornamented with longitudinal rows of cuticular elevations. The four pairs of pedunculated lateral papillæ are equidistant, two pairs being pre-anal and two pairs post-anal. The three pre-anal papillæ are situated in a row just above the anus. Behind the anus there

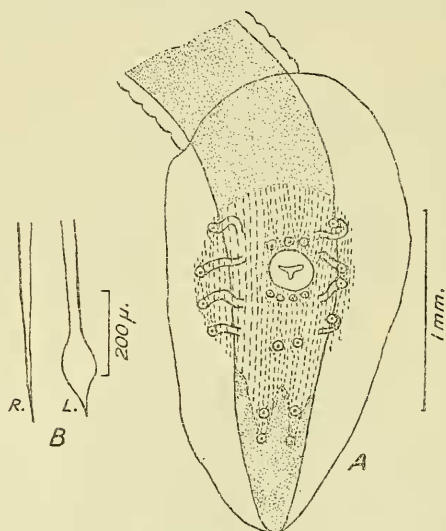
are five pairs of sessile papillæ, of which the first two pairs are small and inserted in a line just behind the anus; the 3rd pair is found at the level of the last part of pedunculated papillæ, the 4th pair in the middle of the tail, and the last just anterior to the front limit of the posterior third of the tail.

The spicules are of equal length, but the base of the right is very slightly thicker than that of the left. They are $455\ \mu$ long, the right being $29\ \mu$ broad at its base and tapering gradually to a fine point, the left being $32\ \mu$ thick as its base and having its posterior end widened out to form a spear-head $160\ \mu$ long by $95\ \mu$ broad.

Host: "Sapakara." Stomach. Dutch Guiana.

Types in the Helminthological Department of the London School of Tropical Medicine.

Text-figure 17.



Physaloptera bonnei, sp. n.

A = Caudal extremity of male. B = Spicules.

This species has many characters in common with *Ph. obtusissima*, as shown by the general shape, ornamentation and arrangement of the papillæ of the male bursa, the nature and size of the teeth, and the general shape of the spicules. It is, however, distinguished from it by its longer cesophagus, slightly more posterior position of the vulva, the presence of a cushion-like swelling anterior to the vulva, the absence of a trunk portion behind the egg-chamber, and in that the spear-head of the left spicule is better set off.

I have named this species after Dr. Bonne, of Surinam, who collected and presented this material to Professor Leiper.

(12) PHYSALOPTERA PHRYNOSOMA, sp. n. (Text-figure 18.)

Numerous specimens were collected from several lizards which had died in the Gardens of the London Zoological Society; unfortunately only a few of the females are mature.

The parasites are slender and much attenuated anteriorly; their greatest diameter is in their posterior third.

The cuticle is smooth (?), and is not reflected over the lips. The cervical papillæ are situated just in front of the level of the junction of the two œsophageal parts, and the excretory pore from 50 to 100 μ behind them on the ventral surface.

The two lips are somewhat conical, and each is surmounted by a large conical tooth, which is inclined slightly outwards; no other teeth are present. Each lip has two papillæ on its outer surface.

The œsophagus is straight, and varies in the females from 1/6th to 1/7th, and in the male it is slightly less than 1/5th of the total body-length; its anterior muscular part passes gradually into the following glandular part, there being little difference in the diameters of the two. The nerve ring encircles its anterior part just in front of the junction of its third and last quarters.

Female.

Fully mature females vary in length from 18 to 23 mm., with breadth from 610 to 760 μ in their posterior third. The genital aperture is non-protuberant, and is situated more or less at the junction of the first and second body thirds; its position varies slightly in different individuals, being sometimes slightly in front of or slightly behind this level. It leads into a short and thick-walled vagina, 380 μ long by 38 μ in diameter; this in turn leads into a well-developed egg-chamber measuring 950 μ long by 152 μ broad; the posterior end of this chamber narrows suddenly and passes into a short common trunk, which after a very short trajet divides into the two uteri; the uteri pass parallel to each other into the posterior sixth of the body.

The eggs are oval and thick-shelled; they measure 50 μ long by 36 μ in diameter.

The receptacula seminis are small and oval, measuring 133 μ by 86 μ .

The tail is relatively long and slender, forming 1/36th of the total length; its caudal pores are situated just behind its middle.

Male.

The males are much slenderer than the females, their average length being 11 mm. by 470 μ broad. The caudal bursa has well-developed alæ, and its ventral surface is covered with longitudinal rows of small tubercles. Two pairs of the stalked papillæ are pre-anal, and two pairs are post-anal in position; they are more or less equidistant from each other, but the pre-anal pair nearest the anus is slightly more dorsal in origin than the others. There are three ventral pre-anal papillæ, the median unpaired one being situated nearer the anus than the other two. Immediately

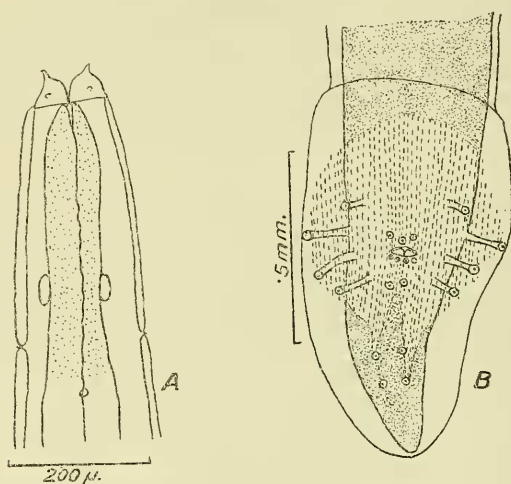
posterior to the anus there are two pairs of small papillæ close together, the one pair being slightly behind the other pair; a small distance behind these there is another pair somewhat obliquely placed and also larger; posterior to the middle of the tail there are two further pairs dividing this part of the tail into thirds.

The spicules are unequal, the right being slightly stouter than the left; both taper to fine points. The right spicule is 180μ long and 10μ broad at its base, while the left spicule is 530μ long and 9μ broad at its base.

Hosts: *Phrynosoma cornutum*, *P. regale*. Stomach. Brazil.

Types to be deposited in British Museum of Natural History, London.

Text-figure 18.



Physaloptera phrynosoma, sp. n.

A = Ventral view of cephalic extremity. B = Caudal extremity of male.

Affinities.—*Ph. abbreviata* has been recorded from this host, but it seems doubtful whether the determination was correct; this species was present in nearly every one of the specimens of *Phrynosomæ* examined by me, which numbered about a dozen, and was the only species present; it is therefore possible that it was this species which was mistaken for *Ph. abbreviata*. As redescribed by Seurat (1914*b* and 1917*a*), *Ph. abbreviata* is readily distinguished from *Ph. phrynosoma* by the fact that it has four uteri, whereas the latter has only two.

The presence of two uteri and a single tooth to each lip allies this species to *Ph. gracilis*, sp. n., and to *Ph. longissima*, sp. n.; it is, however, easily separated from these two species by its much shorter and relatively stouter body.

(13) PHYSALOPTERA GRACILIS, sp. n. (Text-fig. 19.)

The material consisted of about half-a-dozen specimens, all of which were coiled up watch-spring like; as no mature eggs were observed, it is probable that the worms, although fully developed, had not yet reached the reproductive stage.

The cuticle shows a very fine transverse cuticular striation, and it may be partly or wholly reflected over the lips.

The cervical papillæ are situated at the level of the junction of the two œsophageal parts or just posterior to this; the excretory pore is situated on the ventral surface about 40μ further back.

The lips are simple and triangular in side view, and each is surmounted by a large external tooth, triangular in shape, and having a spike-like internal tooth attached to its inner surface; a row of small denticles is present on either side of it, each row being terminated laterally by two larger denticles. External lip papillæ were not observed.

The œsophagus is slender, and retracted from the lips, so that an elongate chamber is formed between it and the lips. The muscular part is slightly thinner than the following glandular part, and forms in the male $1/12$ th and in the female $1/14$ th of the whole organ. The whole œsophagus forms in the male about $1/7$ th and in the female $1/6.2$ of the total length of the body. The nerve ring divides the muscular œsophagus in the ratio of 3 : 2.

Female.

The females vary in length from 20 to 24 mm., and in breadth from 240 to 250μ ; the body is attenuated towards both extremities, but this is only slightly evident posteriorly. The tail is short and pointed, and forms $1/97$ th part of the total length.

The vulva is non-protuberant, and leads into a straight vagina 410μ long by 45μ broad; the egg-chamber which follows is about as wide again as the vagina, and is 730μ long; the common trunk has more or less the same dimensions as the vagina; from its posterior end the two uteri take their origin, and these pass down the body more or less parallel to each other. The position of the vulva divides the body into the ratio of 1 : 2.

No mature eggs were observed.

Male.

The males average about 19 mm. in length by 230μ broad; they are more slender than the females, and do not become attenuated towards the posterior end.

The bursa is small, forming $1/36$ th of the body-length; it is nearly $2\frac{1}{2}$ times as long as it is broad, and its width is only very slightly greater than the maximum body-breadth. Its ventral surface is free from cuticular protuberances, except for a small area surrounding the anus.

The lateral stalked papillæ are arranged three pairs pre-anal

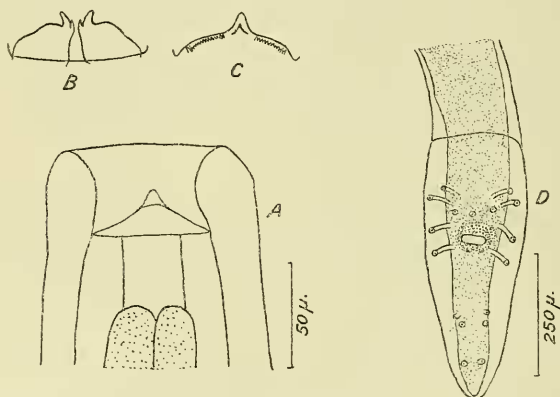
and one pair post-anal; the 1st pair is more ventral in origin than the others, and is also closely approximated to the 2nd pair; the remaining pairs are equidistant from each other. There are three pre-anal and four pairs of post-anal ventral papillæ; the 1st pair of post-anal papillæ are situated immediately behind the anus, the 2nd and 3rd pairs are near together just behind the middle of the tail, and the last pair midway between the 3rd pair and the tip of the tail.

The spicules are unequal, the right being short and stout, measuring $105\ \mu$ long by $23\ \mu$ broad, the left being slender, measuring $273\ \mu$ long by $7\ \mu$ broad at its base; the right spicule tapers to an obtuse point, whereas that of the left side forms a very fine point.

Host: "Lizard." Uganda.

Types in the Helminthological Department of the London School of Tropical Medicine.

Text-figure 19.



Physaloptera gracilis, sp. n.

A = Cephalic extremity, lateral view.

B = Ventral view of lips.

C = Inner view of lip.

D = Caudal extremity of male.

Discussion.—The arrangement of the bursal papillæ in the male, the absence of cuticular markings on the greater part of ventral surface of the caudal extremity of the male, and the character of the lips and its teeth—each of these distinguish this species from all the other reptilian didelphoid forms.

There is some similarity in the arrangement of the bursal papillæ of this species to that found in *Ph. leptosoma* (Gervais), Seurat, 1917, except that just behind the anus there are two pairs in this latter species instead of one. *Ph. gracilis*, however, is easily distinguished from this species by the additional characters of a more elongate body and of much shorter spicules.

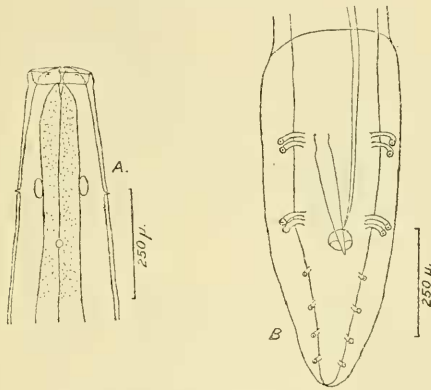
(14) *PHYSALOPTERA LONGISSIMA*, sp. n. (Text-fig. 20.)

The material consisted of about two dozen specimens, some of which were still immature. The specimens are remarkable for their slenderness, the largest females having a thickness of less than 500μ . The body shows very little attenuation towards the extremities.

The cuticle is finely striated transversely, and in some cases it forms a small swelling round the head, whereas in others it is reflected over the lips.

The cervical papillæ and excretory pore occupy a very anterior position, the former being found at the level of the nerve ring, and the latter half-way between the nerve ring and the level of the base of the muscular œsophagus.

Text-figure 20.

*Physaloptera longissima*, sp. n.

A = Ventral view of cephalic extremity.

B = Caudal extremity of male.

The lips are rounded, and each carries only a single tooth, namely the external median; this tooth is triangular in shape, and has its tip slightly recurved outwards. Each lip carries two outer papillæ.

There is no difference in diameter in the two œsophageal parts, the two merging gradually into each other; the whole organ attains $1/7.6$ in the female and $1/6.6$ in the male of the body-length; the muscular part, which is encircled in its middle by the nerve ring, forms nearly $1/8$ th of the whole organ.

Female.

The largest females are 30 mm. long by 438μ broad, and possess a vulva which is situated just in front of the middle of

the body, dividing it in the ratio of 7:8; it leads into a straight vagina 1.3 mm. long, which is directed posteriorly; it then turns forwards to join the trunk, which in its middle bends back again; it is 3.5 mm., long and its anterior half is only slightly differentiated into an egg-chamber; the posterior end of the common trunk divides to give rise to the two uteri. The uteri pass posteriorly almost to the hind end of the body, then pass forwards before joining the oviducts and ovaries, which in their turn pass backwards again.

The body is terminated by a short and rounded tail forming nearly 1/190th part of the body-length.

The eggs are long, oval, and thick-shelled, measuring 59 μ long, 32 μ broad, the thickness of the shell being 5 μ .

Male.

The males average about 22 mm. long by 325 μ broad in their middle.

The bursa is not sharply set off from the body, and is only slightly broader than it; it forms about 1/28th of the body-length; it is little more than twice as long as it is broad, and its ventral surface is devoid of cuticular markings.

The four pairs of stalked papillæ are all pre-anal in position, and arranged in two widely-separated groups of two pairs each. No ventral pre-anal papillæ were seen. Behind the anus there are four pairs of shortly stalked papillæ, which are equidistant from each other and from the anus. They are situated somewhat laterally.

The spicules are unequal, the left being nearly twice as long as the right; the left spicule is slender, and tapers to a fine point; it is 546 μ long by 22 μ broad at its base; the right spicule is from 228 to 300 μ long by 32 μ broad at its base; near its base it has a distinct neck, after which it widens out and then tapers to an obtuse point.

Host: "Snakes." Australia.

Types in the Helminthological Department of the London School of Tropical Medicine.

Discussion.—This species is easily separated from all the didelphoid Physaloptera (1) by the arrangement of the stalked bursal papillæ, these being entirely pre-anal and arranged in two widely-separated groups in this species; (2) by the arrangement and number of the post-anal ventral papillæ; and (3) by the entire absence of cuticular markings on the ventral surface of the tail of the male.

The elongate and slender body shows some similarity to *Ph. gracilis*, sp. n., from which species it is, however, quite distinct, as shown by the above-named three characters; it also differs from this species by the difference in shape of its lips and teeth, by the more posterior position of its vulva, and by its larger spicules.

(15) *PHYSALOPTERA PRÆPUTIALIS* von Linstow, 1889. (Text-figs. 21 & 22.)

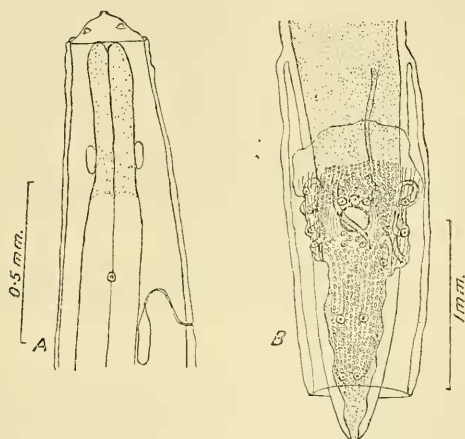
Syn. *Chlamydonema felineus* Hegt, 1910.

Several lots of material were examined, mostly from cats.

The body is slightly attenuated anteriorly, and is surrounded posteriorly by a very loose cuticle, which is partly or wholly reflected over the tail region. The cuticle shows a very fine transverse cuticular striation, and is only slightly reflected over the lips.

The excretory pore and cervical papillæ are situated relatively far back, the former being more posterior in position than the latter. The distance from the anterior end to the cervical

Text-figure 21.



Physaloptera præputialis v. Linst.

A = Lateral view of cephalic extremity.

B = Caudal extremity of male.

papillæ in a male 15 mm. long is $875\ \mu$ and the excretory pore $990\ \mu$; in a female 17 mm. long these distances were $952\ \mu$ and $1123\ \mu$ respectively.

The lips are large and conical, and each carries a subdorsal and subventral external papilla. The external median tooth is large and bluntly triangular; the inner median tooth is of the same height as the outer, and is flattened and tripartite.

The œsophagus is long, and varies in the female from $1/4.8$ to $1/5.4$ of the body-length; in the male it forms about $1/4.5$ of the body-length. The muscular portion of the œsophagus is slightly thinner than the glandular, and is encircled by the nerve ring at the junction of its second and last thirds. It forms about $1/8$ th of the whole œsophagus.

Female.

The females are generally large, and vary in length from 15 to 48 mm. with a maximum thickness of 1 to 1.7 mm. in their posterior half.

The vulva opens a short distance in front of the middle of the body. It is non-protuberant, and its position divides the body into the ratio of 1:1.4 to 1:1.1. It leads into a thick-walled, straight or bent vagina 1.6 mm. long by $114\ \mu$ thick in a female 20 mm. long; its posterior part gradually passes into the egg-chamber, which broadens out posteriorly so as to assume a more or less pyriform shape: in the same female it was $820\ \mu$ long by $228\ \mu$ thick at its posterior end. Two uteri take their origin from the posterior margin of the egg-chamber, a trunk portion being entirely unrepresented. The mode of origin of the uteri is very characteristic, and differs from all those already described; they arise from the posterior lateral margins of the egg-chamber, and not from its base. It thus happens that the uteri, although arising at the same level, are yet far removed from each other.

In most individuals a dark and detachable chitinous ring surrounds the body in the region of the vulva.

The tail is conical and rounded at its tip, and forms from 1/53rd to 1/66th part of the body-length. Its caudal pores open in its posterior half, and their position divides the tail into the ratio of 3:1.

The eggs are oval and thick-shelled, and contain a fully-developed embryo; they average $49\ \mu$ long by $35\ \mu$ in diameter.

Male.

The length of the males varies from 13 to 40 mm. by .7 to 1.3 mm. thick in their posterior third.

The tail is elongate, and is often closely reflexed on to the ventral surface. Its median ventral surface is ornamented with conspicuous and rounded tubercles arranged longitudinally; toward the lateral margins of the tail and on to the alæ these tubercles become gradually replaced by longitudinal ridges, each having a few relatively far removed breaks along its course.

The caudal region, within the cuticular reduplication, appears pointed; this is due to the fact that the caudal alæ, although present, do not open out laterally, but remain irregularly folded towards the ventral surface of the tail. The four pairs of stalked papillæ are thick and equidistant from each other, two pairs being pre-anal and two pairs post-anal. The three pre-anal ventral papillæ are in a transverse row, and the median one is much larger than the other two. Just behind the anus, one pair immediately following the other, there are three pairs of ventral papillæ. Two additional pairs of ventral papillæ are found further down the tail, and their positions divide the tail roughly into thirds.

The spicules are unequal, pointed, and generally curved. The left spicule appears to vary in length from 1 to 1.2 mm., with a thickness of $32\ \mu$ at its base. The right spicule is slightly stouter than the left; its length also appears to vary from 840 to $900\ \mu$ with a thickness of $38\ \mu$ at its base.

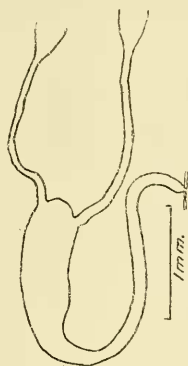
Hosts: *Felis catus domesticus*. Stomach. Federated Malay States, British and Dutch Guiana, China and Ceylon.

Felis nebulosa. India.

Felis pardus. Stomach. Nigeria.

Although my observations as regards the arrangement of the caudal papillæ in the male, the position of the vulva in the female, and the size of the eggs differ considerably from those of von Listow, yet I am quite satisfied that my material belongs to the same species.

Text-figure 22.



Physaloptera præputialis v. Linst.

Terminal portions of female genitalia.

The prepuce-like fold of the cuticle over the tail, the rounded wart-like tubercles on the ventral surface of the tail of the male, the nature of the teeth, the presence of a ring round the body in the vulval region of the female, and the fact that his material is described from *Felis catus*, easily counterbalances the differences in the arrangement of the bursal papillæ. Von Linstow states that this arrangement may be found to be different, as he had only one male for examination, and this specimen he found difficult to study. The ventral papillæ, according to von Linstow, are three pre-anal, one pair immediately behind the anus, three papillæ towards the tail end, and an additional pair slightly in front of these three. He gives the average length of the female as 30 mm., with the vulva 8 mm. from the cephalic extremity and the eggs as 55 by $33\ \mu$.

(16) PHYSALOPTERA MALAYENSIS, sp. n. (Text-fig. 23.)

In external appearance this species appears to be identical with *Ph. preputialis* v. L., with which species it was at first confused. This applies especially to the female, where there is a corresponding similarity in the genitalia.

The cuticle is very slightly reflected over the base of the lips, and in most cases the lips are quite naked. The cervical papillæ are situated about $130\ \mu$ behind the level of the hind end of the muscular œsophagus, and the excretory pore is found about $100\ \mu$ further back.

The lips are rounded, and each bears a large triangular and slightly recurved outer tooth, internal to which is the foliaceous and tripartite inner tooth of equal height.

The œsophagus forms $1/5$ th in the male and $1/6$ th in the female of the total length; its anterior muscular part, which is encircled in its posterior third by the nerve ring, is slightly thinner than the following part, and forms nearly $1/10$ th in the female and $1/7$ th in the male of the total organ.

Female.

Mature females vary in length from 29 to 38 mm., with breadth of from 1.6 to 2.1 mm. The body is attenuated in its anterior third, but posteriorly, because of the looseness of the cuticle and its reflection over the tail, there appears to be only a very slight thinning.

The vulva opens on a slight bulging, and is situated far back, just in front of the middle of the body; its position divides the body in the ratio of 1:1.2 to 1:1.5. Externally the position of the vulva is indicated by a dark chitinous and detachable band encircling the body. The vulva leads into a vagina, which progressively thickens posteriorly to join a progressively thickening egg-chamber; at its vulvular end the vagina is $100\ \mu$ thick, at its posterior end it is $200\ \mu$ thick, and the hind end of the egg-chamber is $330\ \mu$ in diameter; the whole organ is straight, and measures about 3.3 mm. long. From the basal end of this organ the two uteri take their origin like two horns in the same manner as in *Ph. preputialis*.

The eggs are small, thick-shelled, and only slightly ovoid; they are $35\ \mu$ long by 28 to $32\ \mu$ broad.

Male.

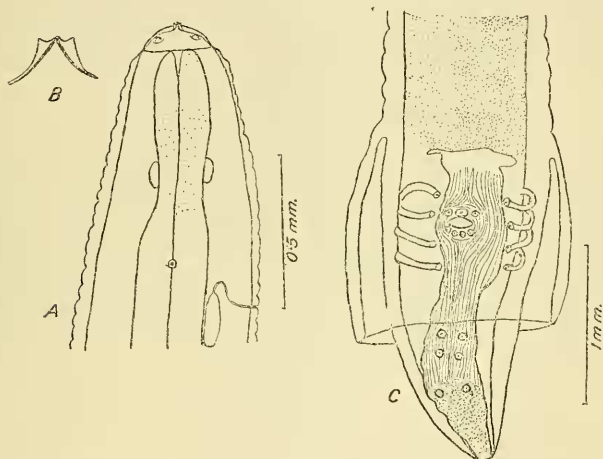
The males are attenuated in their anterior half, and have in most cases the cuticle completely reflected over the tail end; they average in length from 18 to 21 mm., with a maximum breadth of 0.9 to 1.2 mm.

In consequence of the cuticle being reflected over the tail, the bursal expansions are irregularly folded over the ventral surface; they are supported by the usual four pairs of circumloacal stalked papillæ. The whole of the ventral surface is traversed by well-marked and unbroken longitudinal ridges running more or less parallel to each other. The three pre-anal ventral papillæ

are arranged in a row, and the central one is the largest. There are five pairs of ventral post-anal papillæ; pairs 1 and 2 are small, and arranged in a line immediately behind the anus. The 3rd and 4th pairs are approximated to each other just behind the middle of the tail, and the last pair is at about the junction of the second and last thirds of the tail.

The spicules are unequal, that of the left side being about $2\frac{1}{2}$ times as long as that of the right side; their lengths appear to vary in different individuals, but this may probably be due to the fact that the spicules do not lie straight in the body, but often have a wavy course; it is thus difficult to measure them accurately; in this way the left spicule was found to vary from 1.4 to 2.5 mm. in length, with a thickness of 32μ at its base;

Text-figure 23.

*Physaloptera malayensis*, sp. n.

A = Lateral view of cephalic extremity. B = Outer view of median teeth.

C = Caudal extremity of male.

the right spicule is slightly stouter, and varies in length from 580 to 957μ , with a breadth of 36μ at its base. Although there is this marked variation in the sizes, yet it is worthy of note that the ratio of the two spicules was nearly the same in all cases. Unfortunately there was not sufficient material to allow for the dissecting out of the spicules in a series, in order to determine whether this variation was only apparent or real.

Hosts: <i>Felis chaus</i> .	Intestine.	Federated Malay States.
<i>Felis tigris</i> .	Stomach.	Federated Malay States.
"Tiger cat."	"	Federated Malay States.
"Bush cat."	"	Nigeria.
"Hyæna."	Prob. <i>H. striata</i> .	Stomach. Nigeria.

Types in the Helminthological Department of the London School of Tropical Medicine.

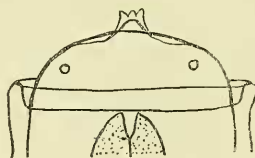
Affinities.—This species, because of its labial armature and female genitalia, forms a distinct group with *Ph. praeputialis* and *Ph. acuticauda*; to the former it is very closely related, as shown by the similarity of the females and the characteristic reflection of the cuticle over the caudal end in both species; it differs from it, however, by the arrangement of its post-anal ventral papillae, its larger spicules, and by the presence of unbroken ridges on the ventral surface of the bursa.

The arrangement of the papillae on the caudal extremity of the male is very similar to that found in *Ph. terdentata*. Apart from this characteristic, and that these two species are both parasitic in carnivores, there appears to be no close affinity between them. *Ph. malayensis* differs from *Ph. terdentata* by the shape and size of its teeth, length of its spicules, presence of unbroken ridges on the male bursa, and in that the cuticle is reflected over the caudal extremity.

(17) *PHYSALOPTERA TERDENTATA* Molin, 1860. (Text-figs. 24 & 25.)

Three bottles of material, Y 1074 from *Felis concolor*, 4511 from *Felis tigrina*, and 4513 from *Felis* sp., labelled *Ph. terdentata* and deposited in the Vienna Museum, were examined. Bottle Y 1074 contained two males, one of which had its head missing. Bottle 4511 contained one female, and bottle 4513 contained one male. The male in the last-named bottle proved to be not *Ph. terdentata* but *Ph. praeputialis* v. Linst. The

Text-figure 24.



Physaloptera terdentata Mol.

Outer view of lip.

female from bottle 4511 had all the characters of the female of *Ph. praeputialis*, except that the cuticle was not reflected over the caudal end, and consequently I am inclined to think that it also is *Ph. praeputialis*. The material from *Felis concolor* proved to be *Ph. terdentata*, and the following description of the male is based on these two specimens.

The complete male is 14 mm. long, and 400μ thick in its posterior third. The body is attenuated anteriorly, and the cuticle is slightly reflected over the lips; externally it shows a coarse annulation, between which a fine transverse striation is

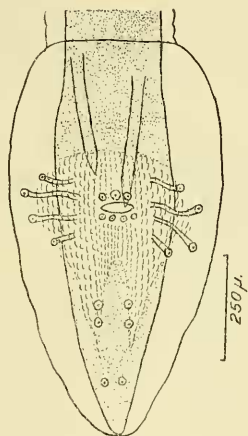
visible under high magnification. The cervical papillæ are lodged about 100μ behind the posterior limit of the muscular œsophagus, and the excretory pore is situated slightly posterior to them.

The lips are large and flatly rounded, and each carries two large and spherical outer papillæ—one in the subdorsal and one in the subventral line. The two terminal teeth are well-defined, the outer being short and stumpy, the inner large and tripartite.

The œsophagus is straight, and consists of the usual two parts; it is 2.3 mm. long or about $1/6$ th of the total body-length. Its anterior glandular part is slightly thinner than the part following, is 240μ long, and has the nerve ring situated in its posterior quarter.

The bursa is elongate with rounded tip, and forms nearly

Text-figure 25.



Physaloptera terdentata Mol.

Caudal extremity of male.

$1/15$ th of the body-length. Its lateral alæ are supported by four pairs of equidistant and somewhat slender stalked papillæ, and are arranged two pairs pre-anal and two pairs post-anal in position. Its ventral surface has longitudinal rows of irregular cuticular bosses. The pre-anal ventral papillæ are situated close together in a row just above the anus, and the middle one is slightly larger than the other two. The post-anal ventral papillæ consist of five pairs, of which pairs 1 and 2 are small and arranged in a row just posterior to the anus, pairs 3 and 4 are situated close behind each other in about the middle of the tail, and pair 5 is found at the junction of third and last quarters of the tail.

The spicules are only slightly subequal, the left being 320μ

and the right 305μ long; they are of equal thickness, 32μ , and they possess a more or less uniform thickness in their anterior four-fifths, the last fifth tapering to a sharp point.

Female.

The female from *Felis tigrina* is 47 mm. long; teeth both large and of equal size, the outer triangular; œsophagus $1/7\cdot3$ of body-length, vulva situated 18·5 mm. from anterior end, the female genitalia as for *Ph. præputialis*, and the cuticle is not reflected over the tail.

Host: *Felis concolor*. Stomach. Brazil.

Type males in bottle 1074 (number on stopper) in the Vienna Museum.

With regard to the name of the host, the legend on the bottle was somewhat indistinct and appeared somewhat like *Felis casiolaris*, but as no feline of this name is known, I take it to mean *Felis concoloris*.

I have placed this species among the didelphoid forms, because the female described may belong to this species, in which case it would come into the group characterised by *Ph. præputialis* v. Linst.

(18) PHYSALOPTERA ACUTICAUDA Molin, 1860. (Text-fig. 26.)

The material on which the study of this species is based is the type material deposited in the Vienna Museum. This material has also been studied by von Drasche. All the specimens were in an excellent state of preservation.

The cuticle is very finely striated transversely, and anteriorly is partly reflected over the lips. In each lateral line, just behind the level of the posterior end of the muscular œsophagus, a small and spike-like cervical papilla is situated, and on the ventral surface about 100μ further back is the opening of the excretory organ.

The lips are somewhat rounded in lateral view, and each carries only two teeth, a large and triangular outer tooth, and immediately internal to it a smaller membranous tooth having its free end tripartite. In the subdorsal and subventral lines of each lip there is a conical papilla.

The œsophagus, which immediately follows the lips, has its anterior muscular part slightly thinner than the following glandular portion: in the male it forms about $1/5\cdot1$ of the total body-length and in the female about $1/7$ th. The glandular part forms about $1/7$ th of the œsophagus, and is surrounded by the nerve ring at the level of its posterior quarter.

Female.

The females have a length of about 30 mm., with a maximum breadth of just over 1 mm. The body tapers in its anterior half, but posteriorly it narrows only in the vicinity of the tail, which is a conical structure about $1/56$ th of the total body-length, and has its caudal pores situated in its posterior third.

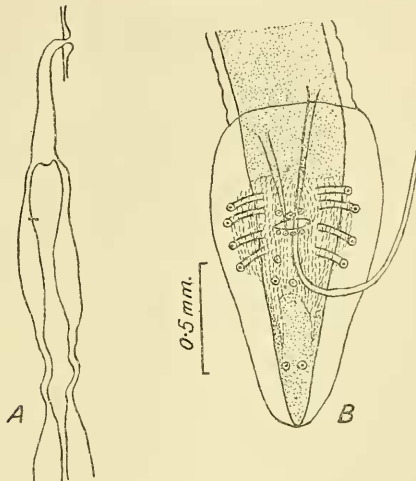
The vulva is situated very far forwards, opening to the exterior on a slight elevation in front of the hind end of the œsophagus. The muscular vagina is very short, measuring only about $480\ \mu$ long by $50\ \mu$ broad; its hind end is very slightly enlarged, and from its outer sides the two uteri take their origin in the same manner as in *Ph. preputialis* v. Linst.; the thin initial portions of the uteri are swollen in their middles, after which they again become thin and also much convoluted, after which they join up with the much thicker and egg-containing part of the uteri.

The eggs are large, oval, and thick-shelled, measuring $51\ \mu$ long by $42\ \mu$ broad; they are fully embryonated *in utero*.

Male.

The males are much smaller and slenderer than the females, measuring only 18 to 23 mm. long by 620 to $740\ \mu$ thick in

Text-figure 26.



Physaloptera acuticauda Mol.

A = Terminal portions of female genitalia.

B = Caudal extremity of male.

their posterior third. From about the posterior third the body tapers gradually towards the anterior end.

The caudal bursa has well-developed lateral wings supported by four equidistant, pedunculated and paired papillæ, two pre- and two post-anal. Of the three pre-anal ventral papillæ the median one is lodged nearer the anus than the other two, and is also larger. There are five pairs of ventral post-anal papillæ, of which the 1st and 2nd pairs are situated in a row immediately behind the anus. The distance between the 4th and last pairs is about twice the distance between the 2nd and 3rd pairs.

The spicules are unequal, tubular, and end in sharp points; that of the left side measures 1.89 to 2.17 mm. long by $45\ \mu$ broad at its base, that of the right 420 to 490 μ long by $50\ \mu$ broad.

Host: *Falco cachinnans*. Œsophagus and stomach. Brazil.

Type material in bottle 4431 in the Vienna Museum.

This species occupies an isolated position among the Physaloptera recorded from birds; none of these in which the nature of female genitalia is known have the uteri arising from the margin of the egg-chamber in a way similar to that seen in *Ph. acuticauda*. This peculiarity of the female genitalia allies *Ph. acuticauda* to *Ph. præputialis* v. Linst. and to *Ph. malayensis*, sp. n., from which species it is, however, very easily distinguished by the very anterior position of its vulva, different arrangement of the male caudal papillæ, and difference of the ornamentations on the ventral surface of the male tail.

GROUP Tetradelphys.

(19) PHYSALOPTERA MORDEN'S Leiper, 1908. (Text-figs. 27 & 28.)

For the study of this species, Prof. Leiper kindly placed at my disposal the type males (three specimens) and also two lots of worms collected by Drs. Turner from man in Africa. In addition, six tubes of worms collected by Dr. Davy from African monkeys were also placed at my disposal for comparison and identification; all these proved to be the same species as that collected from man.

The cuticle shows a very delicate transverse striation; in some specimens an additional coarse and irregular ring, probably due to a certain amount of shrinkage, is present. It is partly reflexed over the lips in some, whereas in others it stops short at the base of the lips. It is somewhat inflated, so that the cervical papillæ appear to be lodged in shallow cuticular pits. The cervical papillæ are situated slightly less than three-quarters of the length of the muscular Œsophagus behind the posterior limit of this Œsophageal part. The excretory pore opens ventrally from 50 to 100 μ further back.

The two lateral lips are large and rounded in lateral view, and are sharply set off from the body in those worms where the cuticle is not reflected over their bases. Each lip carries a large dome-shaped external papilla on each submedian line. Four teeth are present on each lip, one outer and three inner; the outer tooth is large and triangular, and has its tip slightly rounded and recurved outwards. The median inner tooth is very small, and is attached to the base of the outer tooth; it is in the form of a small spike. Leiper states that its inner surface is modified to form a cutting-edge; to me this surface appeared quite flat, or at most slightly convex inwardly. The two inner lateral teeth are situated in the submedian lines, and are directed inwards; each is split longitudinally to its base, and is lodged in a slight elevation of the lip.

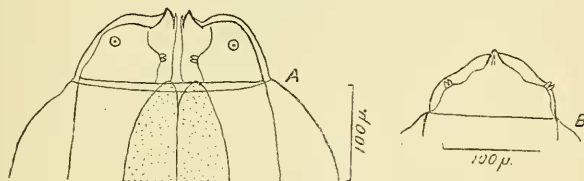
The cesophagus is straight and immediately follows the lips; it thickens very slightly towards the posterior end. Its anterior $1/10$ th, which is slightly thinner than the rest, forms its glandular part, and the nerve ring encircles it in its posterior third. The entire organ forms $1/6.4$ in the male, and $1/6.2$ in the female, of the total body-length.

Female.

The females are large and stout; they vary in length from 41 to 100 mm., with a thickness of 1.8 to 2.8 mm. in their posterior third. The anterior two-thirds taper gradually towards the cephalic extremity; the posterior $1/8$ th tapers to end in a short and conical tail $1/70$ th to $1/90$ th of the body-length; the caudal pores are situated in its posterior half.

The vulva is situated on a slight elevation behind the hind end of the cesophagus; its position divides the body into the ratio of 1:5. The general characters of the female genitalia are exactly similar to those described for *Ph. varani*, except that the common trunk portion behind the egg-chamber is relatively

Text-figure 27.



Physaloptera mordens Leiper.

A = Ventral view of lips.

B = Inner view of lip.

larger. The four uteri are twisted about each other in a complicated way, or fill practically the whole of the body as far as its posterior eighth.

The eggs are oval and thick-shelled, and vary from 45 to 49 μ long by 32 to 34 μ broad. They are fully embryonated when laid.

Male.

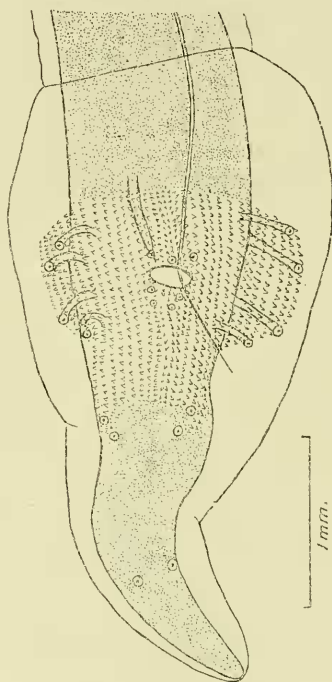
The males vary in length from 29 to 34 mm., with a thickness of .9 to 1 mm. in their posterior quarter; the body is slightly attenuated anteriorly.

The bursa is long and pointed, and is reflexed ventralwards. Its under surface is ornamented with small triangular spike-like processes arranged longitudinally, and extending as far as the 4th pair of post-anal ventral papillæ. The four pairs of stalked papillæ are arranged in two groups, the anterior two pairs being pre-anal and the posterior two pairs post-anal in position; the 1st and last pairs are shorter than the other two, and their origins are slightly more ventral.

The three pre-anal ventral papillæ are of equal size, and are

slightly separated from each other, the middle one being nearer the anus. The first two pairs of post-anal ventral papillæ are small, and are situated close together, one pair behind the other, in the immediate vicinity of the anus; pairs 3 and 4 are approximated to each other, and are situated at the junction of the 1st and 2nd tail thirds; the 4th pair is situated nearer the ventral mid-line than the 3rd pair. The last pair is found at the junction of the posterior tail thirds.

Text-figure 28.

*Physaloptera mordens* Leiper.

Caudal extremity of male.

The spicules are very unequal, the left being long and slender and about eleven times as long as the right; it is filiform, tapers to an acute point, and appears to vary in length from 4.6 to 5.5 mm., with a breadth of 35 μ . The right spicule is short and stout, with its apex tapering to form a long and thin point; it is 470 to 500 μ long by 50 to 55 μ broad at its base.

Hosts: *Homo sapiens*. Stomach and intestine. Africa.

"Monkeys." Stomach. Nyasaland.

My observations differ from Leiper's description, firstly, in the number of uteri, of which he records only two; I was able to

determine their number by dissection, as it is almost impossible to see them by simply clearing and rolling the worms. Secondly, in the size of the females; his longest specimens were 55 mm. long, whereas mine reached 100 mm. And, thirdly, in the size of the spicules; the left spicule, according to my observations, appears to be longer than in his.

The only other *Physaloptera* from man is *Ph. caucasica* v. Linst., 1902. The arrangement of its male bursal papillæ is very similar to that of *Ph. mordens*, except, as Leiper has pointed out, that the 3rd pair of post-anal ventral papillæ is nearer to the mid-line than in *Ph. mordens*. These two species, however, appear to be distinct, as shown by the presence of only one tooth, smaller spicules, and larger eggs, in conjunction with the much smaller body in *Ph. caucasica*.

The nature of the labial armature, mode of origin and number of the uteri, general shape and size of the male bursa, distribution of the bursal papillæ, and the great inequality in the length of the spicules, allies this species to the reptilian species *Ph. abbreviata*, *Ph. varani*, and *Ph. antarctica*. To the mammalian species *Ph. numidica* it is also related, as shown by the number and shape of its teeth and the character of its female genitalia. *Ph. mordens* is, however, easily distinguished from all these by its much larger size, relatively longer trunk portion in the female genitalia, and by its much larger spicules.

The occurrence of this species in monkeys from Nyasaland is very interesting, and leads one to think that these Primates are its normal hosts, man being only an accidental one; this view is further supported by the fact that its only occurrence in man is in the natives of East and Central Africa.

A parallel case in West Africa is the occurrence in monkeys and man of *Esophagostomum apiostomum* (Willach, 1891), Raill. & Henry, 1905.

(20) *PHYSALOPTERA TUMEFACIENS* Henry & Blanc, 1912.
(Text-figs. 29 & 30.)

The material examined consisted of three males and three females, kindly placed at my disposal by Prof. Leiper. This material was part of the collection of worms from which Henry and Blanc described the species, and was presented to Prof. Leiper prior to the publication of their description. In addition, two males, obtained from a *Macacus fascicularis* which had died in the Gardens of the Zoological Society of London, were also studied.

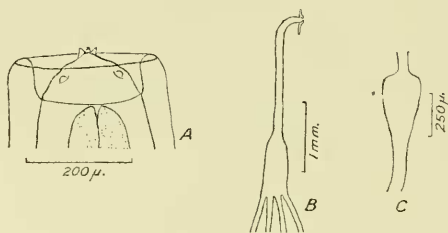
The cuticle is very finely striated transversely, and also shows a coarse cuticular ringings. Anteriorly it is reflected over the lips, and this may also be the case over the tail region in both sexes; this posterior reduplication of the cuticle may pass over as much as the anterior third of the bursa in the male; in the females it only forms a narrow collar in front of the anus. The

cervical papillæ vary in position; in one they are placed at the junction of the two œsophageal parts, in the others up to 150μ further back; they may be symmetrical or asymmetrical in position. The excretory pore is found about 70μ behind the cervical papillæ.

The two lateral lips are large and conical in side view, and each carries two large submedian papillæ on their outer convex surface. Only two teeth are present—a large and conical outer tooth with obtuse tip and slightly bent outwards, and a flattened and broad inner tooth, of the same size as the outer, and having its free end divided into three cusps of the same size.

The œsophagus is straight, and forms in the female $1/5.2$ to $1/5.4$, in the male $1/4.6$ to $1/5.2$ of the total body-length; its anterior $1/11$ th or $1/12$ th forms its muscular part, which is slightly thinner than its posterior glandular portion. The nerve ring encircles it in its posterior third.

Text-figure 29.

*Physaloptera tumefaciens* Henry & Blanc.

A = Lateral view of lips. B = Terminal portions of female genitalia.
C = Receptaculum seminis.

Female.

The three females are 50, 38, and 36 mm. long, with a thickness of respectively 1.9, 1.5, and 1.2 mm. The anterior half tapers considerably, but posteriorly this tapering is limited to the last 4 or 5 mm. The tail is conical, and forms from $1/57$ th to $1/65$ th part of the body. Its caudal pores are situated in slight pits in the posterior half of the tail; their position divides the tail into the ratio of 5 : 2.

The vulva opens on a slight elevation, which divides the body into the ratio of 1 : 2.9; in one of the females it is situated in front of the end of the œsophagus; this position is probably due to shrinkage of the anterior part of the worm, as shown by the facts that the cuticle in this region is much corrugated and that the intestine immediately behind the œsophagus is thrown into a loop.

The genitalia pass straight back, and are specially characterized by the absence of a common trunk portion behind the egg-chamber, and by the presence of four uteri arising all together from the hind end of the egg-chamber. The vagina, in the

largest female, is 1.7 mm. long by 100μ thick, and the egg-chamber 800μ long by 270μ broad at the origin of the uteri. The receptacula seminis are pear-shaped, and are sharply constricted off from the oviducts, their union with the uteri being gradual; they are 380μ long by 200μ broad at their oviducal end.

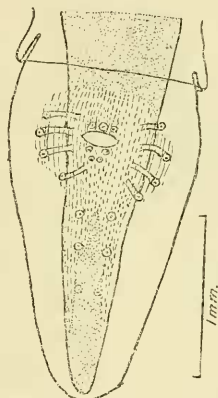
The eggs are oval and thick-shelled, and average 43μ long by 27μ thick. They contain a fully-developed embryo when laid.

Male.

The males vary in length from 26 to 31 mm., and are attenuated in their anterior two-thirds; they vary in thickness from 1 to 1.2 mm.

The bursa is narrow and elongate and rounded at its tip; its anterior part may or may not be covered over by a posterior

Text-figure 30.



Physaloptera tumefaciens Henry & Blanc.

Caudal extremity of male.

reflection of the cuticle. Its central ventral area is ornamented with irregular tubercles arranged longitudinally; laterally in the cloacal region these tubercles are replaced by longitudinal ridges.

The four stalked papillæ are short and arranged equidistant from each other round the cloaca. The three pre-anal ventral papillæ are situated in a row just anterior to the anus; the central papilla is large. There are five pairs of post-anal ventral papillæ, of which the first two pairs are small and situated close together, one behind the other, immediately posterior to the anus. Papillæ 3 are situated at the anterior quarter of the tail, and papillæ 4 half-way between them and the middle of the tail. Papillæ 5 are slightly approximated to the mid-line, and are situated slightly behind the middle of the tail.

The spicules are bent, thick, short, and slightly unequal.

They are of equal thickness, and both taper to fine points. The right varies from 475 to 520 μ long by 55 μ thick, and the left from 740 to 870 μ long, with the same thickness as the right.

Hosts: *Macacus cynomolgus*. } Stomach. India.
Macacus fascicularis. }

My observations on this species are practically identical with those of Henry and Blanc; the only differences are in the size of the egg, which appears slightly smaller in my material, and in the size of the spicules, mine being slightly larger.

Ph. tumefaciens, *Ph. mordens*, *Ph. numidica*, and *Ph. magnipapilla* are the only 4-uterine forms described from mammals. *Ph. mordens* and *Ph. numidica* have teeth as in *Ph. paradoxa*, whereas *Ph. magnipapilla* and *Ph. tumefaciens* have each only two teeth to each lip. *Ph. tumefaciens* is distinguished from the other three species by the mode of origin of its uteri, by the absence of a common trunk portion in the female genitalia, and by the reduplication of the cuticle over the caudal extremity in most individuals of both sexes.

(21) PHYSALOPTERA MAGNIPAPILLA Molin, 1860. (Text-fig. 31.)

Some of the excellently preserved type material in the collection of the Vienna Museum was examined.

The body appears smooth, but under high magnification the cuticle is seen to be provided with very delicate transverse striations. It is slightly reflected over the base of the lips, and in some females it was reflected over the whole of the tail in a manner similar to that seen in *Ph. præputialis*.

The cervical papillæ are small and spike-like, and pierce the cuticle about 150 μ behind the level of the hind end of the muscular œsophagus; from 75 to 100 μ further back on the ventral surface the opening of the excretory duct is found.

The lips are somewhat quadrangular, with large subdorsal and subventral external papillæ, and each is provided with two teeth of the same height; the outer tooth has a widened tip, whereas the median inner tooth is tripartite.

The œsophagus immediately follows the lips. It is straight, and forms in the female 1/5.5 and in the male 1/6.6 of the total body-length. Its anterior muscular part is nearly 1/10th of the whole organ, is slightly thinner, and is encircled in its posterior third by the nerve ring.

Female.

The females vary from 30 to 38 mm. long by .9 to 1.1 mm. broad; they are attenuated in their anterior fourth and posterior fifth, and the body is terminated by a bluntly conical tail 1/52nd of the body-length and having its caudal pores in its posterior half.

The vulva opens level with the surface, and its position divides the body in the ratio of 1:2.3; it leads into a straight muscular vagina nearly 2 mm. long by 80 μ thick. The egg-chamber is

slightly shorter, and about three times as broad as the vagina. The common trunk is about 1.1 mm. long and 75μ thick; its posterior end divides twice, in the same way as seen in *Ph. abbreviata*, to give rise to the four uteri.

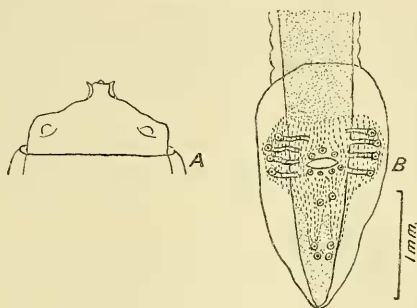
The eggs are small, oval, and thick-shelled, measuring on an average 40μ long by 26μ broad; when laid they are already fully embryonated.

Male.

The males are much smaller than the females, and measure from 20 to 25 mm. long, with a maximum breadth of .7 to .85 mm. The body is attenuated in its anterior half, the posterior half being of uniform thickness.

The bursa is pointed and recurved ventralwards. The four pairs of pedunculated papillæ are equidistant, three pairs being pre-anal. The three pre-anal ventral papillæ are small, and are

Text-figure 31.



Physaloptera magnipapilla Mol.

A = Lateral view of lip.

B = Caudal extremity of male.

situated immediately in front of the anus. The first two pairs of post-anal ventral papillæ are also small and situated in a row in close proximity to the anus. The 3rd pair is larger and slightly obliquely placed; they divide the tail roughly into the ratio of 1:3. The 4th and 5th pairs are small and approximated to each other, and are situated just behind the middle of the tail. The ventral surface of the bursa is ornamented with longitudinal rows of tubercles.

The spicules are straight, tubular, pointed, and slightly unequal; the left is 450μ long by 26μ broad at its base, and the right is 415μ long by 20μ broad at its base.

Host: *Myrmecophaga bivittata*. Stomach. Brazil.

Types in bottle 4457 in the Vienna Museum.

My observations differ from those of von Drasche only in respect to the teeth; he states that the outer tooth is small, and in his figure shows it smaller than the inner tooth. In the worms

examined by me the two teeth were of the same size and fairly large.

The number of uteri and their mode of origin brings the species into the group characterised by *P. abbreviata*. It differs, however, from all the reptilian tetradelphoid forms by the shape of its outer tooth and by the presence of a large and tripartite inner tooth; this latter tooth is either absent—*Ph. colubri*—or represented only by a small spike-like tooth at the base of the outer tooth—*P. paradoxa*—in the reptilian forms.

The nature of the teeth and the presence of four uteri ally this species to *Ph. tumefaciens* Henry & Blanc, 1912, from which species it differs, however, by the different arrangement of its bursal papillæ, no reduplication of the cuticle over its tail, mode of origin of its uteri, and the presence of a common trunk portion in its unpaired female genitalia.

(22) PHYSALOPTERA QUADROVARIA Leiper, 1908. (Text-fig. 32.)

The types of this species, which were kindly placed at my disposal for study by Professor Leiper, consisted of six mature females and one male; the latter unfortunately had most of its bursal region broken off.

The parasites are stout, being thickest just behind their middle and attenuated towards both extremities. The cuticle shows a fine transverse striation, and is partly reflected over the lips.

The two cervical papillæ are situated laterally some distance behind the junction of the two œsophageal parts. In the male they are $550\ \mu$ from the anterior end, and in the females slightly more than $600\ \mu$. The excretory duct opens ventrally at the same level or just behind the level of the cervical papillæ.

The lips are large and somewhat flattened in lateral view; each carries a large wedge-shaped external tooth with its tip slightly bent outwards, and two much smaller lateral teeth slightly split. Between the median and lateral teeth, on the inner face of the lip, there is a row of very small denticles. Internal to and attached to the base of the external tooth there is a small and spike-like internal tooth.

The œsophagus is relatively short, forming in the male $1/7$ th and in the female about $1/9$ th of the total body-length; it is straight, slightly thickening posteriorly, and its anterior end is differentiated into a short and narrow muscular part, about $350\ \mu$ long in both sexes, and having the nerve ring in its posterior quarter.

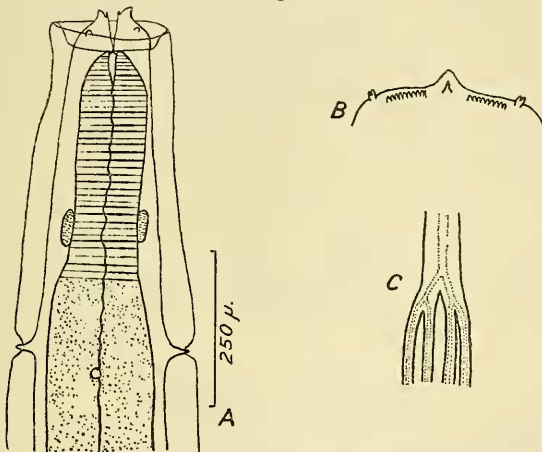
Female.

The specimens vary in length from 28 to 32 mm., with a breadth of .95 to 1.1 mm. The tail is relatively long and

pointed, forming $1/45$ th of the total body-length, and has its caudal pores situated in its posterior third.

The vulva is situated on a slight elevation at the junction of the 1st and 2nd body fifths; it leads into a long and thick-shelled vagina 2.2 mm. long by $95\ \mu$ broad. This vagina passes straight backwards to join the egg-chamber, which is also large and straight, measuring 1.8 mm. long by $380\ \mu$ broad. The hind end of this chamber narrows sharply to join the common trunk, which is $760\ \mu$ long and $90\ \mu$ in diameter; its posterior end divides into two, each of which in their turn subdivide to give rise to the four uteri. These two primary branches are so short as to almost give the appearance that the uteri all arise at the same level.

Text-figure 32.



Physaloptera quadrovaria Leiper.

A = Anterior extremity of body. B = Inner view of lip.

C = Mode of origin of uteri.

The eggs are thick-shelled and oval, measuring $51\ \mu$ long by $36\ \mu$ broad; they embryonate *in utero*.

Male.

The solitary and incomplete male is 19.5 mm. long and $750\ \mu$ thick. Part of the left spicule—the bursa is broken off just in front of the anus—is seen inside the body, but nothing remains of that of the right side. The remaining portion of the left spicule is long and filiform, measuring 1.3 mm. long. The spicules are probably very unequal.

Host: *Varanus niloticus*. Intestine. Sudan.

Discussion.—See *Ph. varani*.

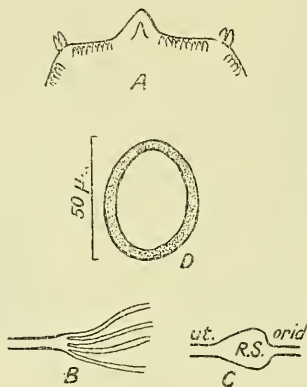
(23) *PHYSALOPTERA PARADOXA* von Linstow, 1908. (Text-figs. 33 & 34.)

Syn. *Ph. affinis* Gedoelst, 1916.

The primary study of this species is based on materials collected in the Zoological Society's Gardens from *Varanus albigularis*. All the specimens from the other hosts were kindly handed over to me by Professor Leiper for study and comparison. The material from *Varanus albigularis* consisted of about a dozen males and females, which had unfortunately been killed in formalin, so that the specimens were somewhat shrunken and coiled.

The shape of the body is very similar to that of *P. quadrovaria*, but is much smaller in size, mature females varying from 18 to

Text-figure 33.



Physaloptera paradoxa v. Linst.

A = Inner view of lip. B = origin of uteri.
C = Receptaculum seminis. D = Egg-shell.

24 mm. in length with a thickness of 750 to 870 μ in their posterior third, and the males from 14 to 18 mm. long by 450 to 500 μ broad in their posterior fifth.

The cuticle is coarsely annulated and, in addition, shows a very fine transverse striation; it is only very slightly reflected over the base of the lips. The cervical papillæ and excretory pore are situated in the same level behind the junction of the muscular and glandular œsophageal parts; in the male they are about 550 μ from the anterior end and in the female about 750 μ .

The lips are similar to those described for *Ph. quadrovaria*, except that lateral to each of the outer teeth there is another

row of small denticles on the inner surface parallel to the edge of the lip.

The muscular part of the œsophagus is thinner than the glandular part, and is encircled by the nerve ring at its base. The whole organ is short, and forms in the females $1/7$ th and in the males nearly $1/8$ th of the total body-length.

Female.

The vulva opens practically flush with the surface, there being only a slight trace of an elevation. Its position is post-œsophageal, and divides the body in the ratio of $1:2.4$; it leads into a long and thick-walled vagina about 2 mm. long by 100μ broad; its most anterior portion is slightly twisted. The following egg-chamber is straight, and lies parallel to the intestine; it is slightly thicker than the vagina but shorter, measuring 1.2 mm. long by 133μ broad. The following common trunk is relatively short, and is thinner than the vagina; it is 570μ long and 57μ thick. From its posterior end the four uteri take their origin at the same level, but their cavities arise by a double subdivision of the unpaired duct. The uteri at first pass forwards to beyond the posterior end of the œsophagus, after which they bend backwards and fill the body almost to the posterior end.

The eggs are thick-walled, oval, and fully embryonated *in utero*; they measure 50μ long by 35μ broad.

The body is terminated by a relatively long and pointed tail, forming $1/47$ th of the total length; its caudal pores are situated just behind its middle.

Male.

The caudal bursa is large and provided with well-developed alæ; its ventral surface is traversed by coarse cuticular elevations arranged in longitudinal rows. The anus is a large and transversely oval aperture, with a thickened rim, very prominent when viewed from the ventral surface; it is situated about 850μ from the tip of the tail.

The four pairs of pedunculated papillæ are equidistant from each other; two pairs are pre-anal and two pairs are post-anal in position; of the three pre-anal ventral papillæ the median one is situated slightly closer to the anus than the other two. Behind the anus there are five pairs of sessile papillæ: the 1st and 2nd pairs of these are small, and situated close together just behind the anus, one pair behind the other; the 3rd and 4th pairs are closely approximated, and found just in front of the middle of the tail; while the last pair is situated just posterior to the front margin of the posterior quarter of the tail.

The spicules are very unequal, and appear to vary in size; but these variations may be due to the difficulty found in measuring them. The right spicule is short, and varies from 185 to 240μ

long, with a thickness of 50μ at its base; the left spicule is long and filiform, varying from 1.8 to 2.8 mm. long; it is about 15μ thick at its base; both spicules terminate in sharp tips.

Hosts: *Varanus albigularis*. Stomach. South Africa.

Psammodphis sibilans. " Sudan.

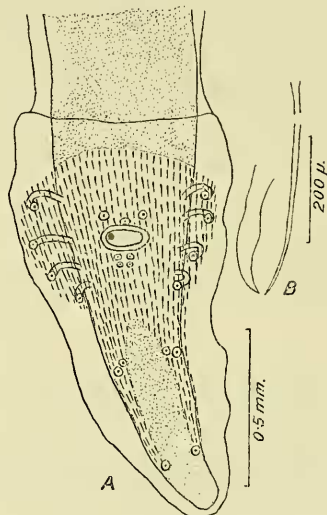
"Snake." " Nigeria.

"Colubrine snake." " Sudan.

"Snake." " Nigeria.

Discussion.—My observations differ slightly from those of Seurat (1914 b) made on parasites obtained from *Varanus griseus* and *Cerastes cornutus*. These differences apply to the spicules, which are 100μ and 1.92 mm. long for the right and left spicule respectively in Seurat's material, whereas in my material

Text-figure 34.



Physaloptera paradoxa v. Linst.

A = Caudal extremity of male.

B = Spicules (only part of left indicated).

the right spicule varied in length from 185 to 240μ and the left from 1.8 to 2.8 mm. Also the eggs in his specimens are 10μ broader than in mine. Despite these differences I believe the parasite to be the same, and the difference in size of the spicules can be accounted for in that it is not always possible to measure them correctly, as they generally take up a twisted course inside the body.

Von Linstow (1908), in his description of this species, draws attention to the absence of caudal alae on the tail of the male, and for this reason gave it the name "*paradoxa*." Seurat (1914)

explains this absence by supposing that von Linstow was examining immature material, as he (Seurat) had in his possession immature specimens of *Ph. alata* in which the caudal alæ were also absent. Unfortunately, I have not in my collection any Physaloptera in this condition, and consequently I accept Seurat's interpretation.

There is, however, another difference between von Linstow's observations and mine; this concerns the number of the post-anal ventral papillæ. Von Linstow finds an extra pair present behind the second, whereas in my material there is no indication of these papillæ, neither were they present in Seurat's (1914) material. It is therefore probable that von Linstow was mistaken in his observations, especially as my material and his are from the same host, both from South Africa, and there further appears no reason to doubt the identity of the two materials.

(24) PHYSALOPTERA VARANI Parona, 1889. (Text-fig. 35.)

The material on which the study of this species is based consists of three males collected from *Varanus bengalensis* and two females collected from *V. indicus*. I wish to express my indebtedness to Professor Leiper for placing this material at my disposal.

The body is attenuated towards both extremities, and shows a coarse transverse ringing in addition to a very fine transverse cuticular striation. The cuticle is partly reflected over the lips.

The cervical papillæ are situated laterally a short distance behind the junction of the two œsophageal parts; on the same level or just posterior to it is the opening of the excretory gland.

The two lateral lips are large and tall. Each is provided with a large external tooth whose tip is slightly recurved; attached to it on its inner surface there is a small and membranous spike-like tooth, and on each side of it, towards the angles of the lips, there is a small bifid tooth. Externally each lip carries a large subdorsal and subventral papilla.

The œsophagus is long, and forms in the male $1/6$ th and in the female $1/5.5$ of the total body-length. Its anterior muscular part is slightly thinner than the following glandular part, and the nerve ring encircles it about $80\ \mu$ from its base.

Female.

The two females are respectively 35 and 17 mm. long by 1 mm. and $530\ \mu$ broad; the body is terminated by a pointed tail $1/80$ th of the total length, with its caudal pores just behind its middle.

The vulva is non-protuberant, and is situated at the junction of the 1st and 2nd quarters of the body; it leads, in the smaller female, into a thick-walled vagina $950\ \mu$ long by $85\ \mu$ in diameter; this passes gradually into the egg-chamber, which is 1.8 mm. long and $170\ \mu$ thick. The common trunk which follows it is 1.14 mm. long and $50\ \mu$ in diameter. The first two parts pass

straight down the body, whereas the common trunk is recurved and passes forwards parallel to the other parts. The posterior end of the common trunk divides into two branches, each of which in their turn, after a distance of 120μ , subdivide to give rise to the connections of the four uteri.

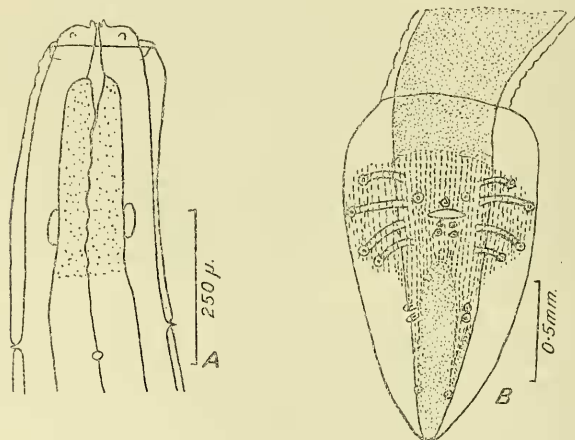
The eggs are oval and thick-shelled, and contain fully embryonated embryos before being laid. They are 53μ long by 32μ in diameter.

Male.

The males are respectively 12, 21, and 24 mm. long, the largest being 800μ thick in its posterior quarter.

The caudal bursa is large, and nearly twice as long as it is broad. The papillae are arranged in identically the same way as those described for *Ph. paradoxa*, as also are the tubercular

Text-figure 35.



Physaloptera varani Parona.

A = Ventral view of cephalic extremity.

B = Caudal extremity of male.

elevations. The outline of the bursa, however, is slightly different, its length and breadth being respectively relatively shorter and broader than in *Ph. paradoxa*.

The spicules are very unequal and bent, and both end in sharp points. The right is broad, with almost parallel edges except for its posterior tenth; it is 342μ long by 25μ broad at its base. The left spicule is long and filiform, 2.1 mm. long by 14μ broad at its base.

Hosts: *Varanus bengalensis*. Stomach. Ceylon.

Varanus indicus. „ India.

Discussion.—Seurat (1917 a) considers this species to be identical with *Ph. paradoxa* v. Linst. and *Ph. quadrovaria* Leiper.

After a study and comparison of these three species, I hold that, although they are nearly related, they must be regarded as distinct species. *Ph. varani* differs from *Ph. paradoxa* by its longer œsophagus, longer trunk, mode of origin of the four uteri, and the absence of a denticular ridge on the inner side of each lip. It differs from *Ph. quadrovarya* by its longer œsophagus, shorter tail of the female, less evolved type of origin of the uteri, and also by the absence of denticles on the inner surface of the lips.

Ph. varani appears to be very closely related to *Ph. abbreviata*, as redescribed by Seurat (1914*b* and 1917*a*), with which species it agrees in the female genitalia. It appears, however, to differ from *Ph. abbreviata* in its larger size, absence of denticles on the inner surface of the lips, relatively shorter bursa, and larger spicules. I have unfortunately not been able to examine and compare any examples of *Ph. abbreviata*.

Ph. pallaryi Seurat, 1917, seems to be a near relative of *Ph. varani*, from which species it can, however, be very easily distinguished by its much shorter left spicule, the conformation of the circumcloacal area, and by the position of the vulva in front of the posterior limit of the œsophagus.

Parona's (1889) description differs from my findings in that he mentions and figures the presence of four pairs of post-anal ventral papillæ, the last three pairs of which are equidistant from each other, the 1st pair being situated immediately behind the anus. I think an error has crept in his observations: namely, that he has missed one pair of small papillæ just behind the 1st, and has misjudged the distance separating the 2nd and 3rd pairs in his figure. I am led to this view because I think his specimens could not have been well preserved, as he shows the caudal alæ having a lobulated border, a state of affairs which I have noticed to take place in contracted specimens. I do not think there can be any doubt as to the identity of the materials, although Parona's description is so incomplete that it can apply to quite a number of Physaloptera.

(25) PHYSALOPTERA ANTARCTICA v. Linstow, 1899. (Text-figs. 36 & 37.)

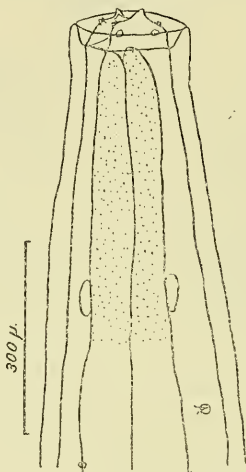
Syn. *Ph. alba* Stoss., 1902.

Female.

Mature and fully-grown females are about 45 mm. long and 950 μ broad. The body is of more or less uniform thickness, only tapering slightly towards the anterior end. The body is terminated by a short tail about 440 μ long. The cuticle is roughly ringed, and between these rings a very fine cuticular striation is observed under high-power magnification; the cuticle anteriorly is partly drawn over the lips. The cervical papillæ are lodged in shallow pits in the cuticle, and are situated about 650 μ

from the anterior end; the excretory pore is seen on the ventral surface about 95μ further back; it leads into the excretory duct, which passes into a gland lying against the ventral surface of the oesophagus. The two lateral lips are each surmounted by a large triangular tooth, slightly recurved at its tip; applied to the inner surface of each is a small spike-like tooth. On either side of the median tooth, in the lateral angles of each lip, there is seen another tooth, much smaller than the terminal tooth and split almost to its base; just below these and on the outer surface of the lip there is a conspicuous papilla. The lips are immediately followed by the oesophagus, which is straight and thickens slightly towards its posterior end. It is about 4.7 mm. long or $1/9.5$ of the body-length, and is divided into a short and narrower

Text-figure 36.

*Physaloptera antarctica* v. Linst.

Latero-ventral view of cephalic extremity.

anterior part about 475μ long and a longer posterior glandular part. The first part is surrounded near its base by the large nerve ring.

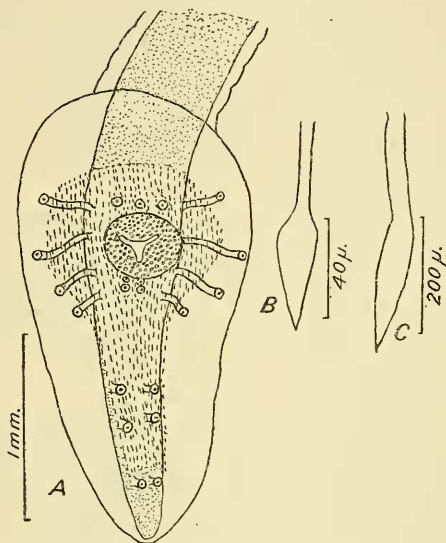
The chief characteristics of the female genitalia is the presence of four uteri. The vulva is a circular aperture, flush with the surface and situated at about the junction of the 1st and 2nd quarters of the body. It leads into a short and slightly coiled vagina, very muscular and about 90μ in diameter. It is followed by the egg-chamber, about 259μ in diameter; the hind end of this chamber constricts suddenly, so that the common trunk has about the same diameter as the vagina. The common trunk divides posteriorly into two branches, and these after a short distance subdivide again. The four uteri thus formed may first

pass forwards to beyond the junction of the œsophagus and intestine and then pass backwards, or they may pass backwards directly. The uteri are more or less parallel, and their hinder ends pass gradually into the receptacula seminis, about 380μ long by 150μ broad. The receptacula seminis pass abruptly into the oviducts, 38μ in diameter, which soon join the ovaries; the latter pass forwards, taking more or less a convoluted course.

Male.

The males are slenderer than the females, fully-grown forms being about 32 mm. long and 750μ broad. The body is only

Text-figure 37.



Physaloptera antarctica v. Linst.

A = Caudal extremity of male. B = Tip of left spicule.
C = Right spicule.

slightly attenuated anteriorly. The cuticle is of the same character as the female, and the cervical papillæ occupy relatively the same position, being situated a short distance beyond the junction of the muscular and glandular portions of the œsophagus. The excretory pore is situated ventrally about 130μ further back than the cervical papillæ. The lips are as described for the female.

The first part of the œsophagus is thinner than that following, measures about 500μ long, and is surrounded at its base by the nerve ring. The total length of the œsophagus is 3.55 mm. or 1/9th of the body-length.

The bursa is large, being about $2\frac{1}{2}$ mm. long by $1\frac{1}{4}$ mm. broad across the cloaca. The lateral expansions are well developed, and the central portion of the ventral surface is covered by longitudinal rows of spike-like tubercles. The anus is a triradiate aperture, situated in the centre of a more or less circular cushion like a swelling, about $420\ \mu$ in diameter, and itself covered with small tubercles. On either side of it there are four elongate papillæ, implanted equidistant from each other. Anterior to the cushion there are three ventral papillæ of equal size and situated in a row; immediately posterior to the cushion there are two small pairs of ventral papillæ. There are three other pairs of ventral papillæ further down the tail, of which the middle pair is nearer to the anterior than to the posterior pair. These last three pairs of papillæ are each provided with a short stalk.

The spicules are unequal, that of the left side being longer than that of the right side. The left spicule measures $1504\ \mu$ long by $19\ \mu$ broad at its base; at its tip it widens out to form a kind of spear-head $64\ \mu$ long by $18\ \mu$ broad. The right spicule is stout, and measures $410\ \mu$ long by $33\ \mu$ broad at its base. In its posterior two-fifths it becomes slightly widened out, after which it gradually tapers to a point.

Hosts: *Varanus varius*. } Stomach. Australia.
Python spilotes. }

My material has been identified as *Ph. antarctica* v. Linst. because of the general agreement of the measurements of my material with those of von Linstow's; the only important difference is the relative length of the tail of the female; von Linstow gives it as $1/54$ th of the body-length, whereas in my material it forms only about half this length.

Only two species have so far been described from Australian lizards—namely, the species described by von Linstow and *Ph. alba* described by Stossich (1902). Irwin-Smith (1922) considers these species to be the same, and I am inclined to agree with her. Unfortunately, I have not been able to examine material from any of the hosts from which these two species were obtained, but from the brief descriptions and figures given by von Linstow and Stossich it appears probable that they are identical.

Ph. antarctica, because of the nature of its labial teeth and mode of origin of the four uteri, is closely related to *Ph. abbreviata*, *Ph. varani*, and *Ph. pallaryi*; it is, however, very easily distinguished from all these by the configuration of its male bursa and by the difference in size and shape of the spicules. I have given an extract of both von Linstow's and Stossich's descriptions in Part II.

(26) *PHYSALOPTERA COLUBRI* (Rud., 1819), Diesing, 1851. (Text-fig. 38.)

The types of this species, deposited in the Vienna Museum, consisted of two immature females and the fragments of another worm; the specimens were slightly shrunken.

The cuticle is finely striated transversely, and is partly reflected over the lips; the cervical papillæ are situated about $100\ \mu$ behind the level of the hind end of the muscular œsophagus, and the excretory pore about $75\ \mu$ further back.

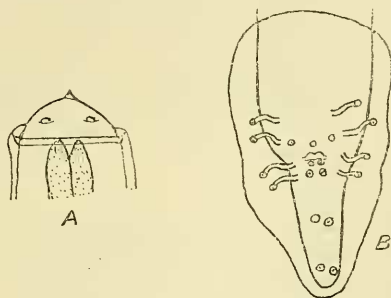
The lips are rounded, and each is surmounted by a single large terminal tooth, no other teeth being present. Externally each lip carries a small subdorsal and subventral papilla.

The œsophagus forms nearly $1/4.6$ of the body-length; its anterior muscular part is thinner than the rest, and it is encircled by the nerve ring in its posterior third; it forms just less than $1/10$ th of the whole organ.

Female.

The two specimens measure respectively 7 and 8 mm. long by 350 and $360\ \mu$ broad; the body is attenuated in its anterior half, and it is terminated behind by a relatively long and bluntly rounded tail, which is turned up dorsally in both specimens; it

Text-figure 38.



Physaloptera colubri (Rud.), Dies.

A = Lateral view of lip.

B = Caudal extremity of male. (After v. Drasche.)

is about $1/30$ th of the body-length, and its caudal pores are situated in its posterior third. The vulva is only very slightly protuberant, and its position divides the body into the ratio of $1 : 2.5$; it leads into a vagina bent on itself and measuring $1\frac{1}{4}$ mm. long by $55\ \mu$ thick; the egg-chamber is $320\ \mu$ long by $145\ \mu$ in diameter, and is also bent on itself; the following common trunk is of about the same length as the egg-chamber, and is about $50\ \mu$ broad; its posterior end divides into two, each of which, after a distance of $240\ \mu$, again divides into two to give rise to the four uteri.

No eggs were observed, the specimens being immature.

Male.

The following description of the male bursa is based on von Drasche's description and drawing, no males being available for personal study.

The caudal expansions are well developed, and the four pairs of stalked papillæ are situated in two groups, two pairs being pre-anal and two pairs post-anal. The three pre-anal ventral papillæ are of the same size, the middle one being nearer the anus than the other two.

There are four pairs of post-anal ventral papillæ, of which the 1st is small and situated immediately behind the anus; the 2nd, 3rd, and 4th pairs are equidistant, the 2nd being situated at the level of the last pair of stalked papillæ, and the last near the tip of the tail.

Host: *Coronella austriaca*. Intestine. Australia.

Types in bottle 4451 in the Vienna Museum.

It is probable that when the male of this species is re-examined, it will be found that there are five pairs of post-anal ventral papillæ, and that the extra papilla will be situated near the 1st pair just behind the anus.

(27) *PHYSALOPTERA SIMPLICIDENS*, sp. n. (Text-fig. 39.)

The material examined consisted of three females, two of which were immature, one small male, and one larger male which had its bursa broken off.

The cuticle is finely striated, and is slightly reflexed over the lips; the cervical papillæ are situated in small concavities just behind the junction of the muscular and glandular parts of the oesophagus. The excretory pore is situated on the ventral surface about $60\ \mu$ further back.

The lips are somewhat flatly conical in side view, and each bears a large triangular tooth, slightly recurved outwards; no other teeth were observed. Each lip carries two papillæ, one subdorsal and one subventral, on its outer surface.

The oesophagus is short, and in the female forms $1/13$ th and in the male $1/8$ th of the body-length; its anterior muscular part forms about $1/9$ th of its length, and is distinctly separated from the following glandular part; it is encircled by the nerve ring in its posterior quarter.

Female

The females are about 44 mm. long and $950\ \mu$ broad, and are attenuated towards both extremities; this is only slightly evident posteriorly where the body is terminated by a short and conical tail, forming $1/105$ th of the body-length. The vulva divides the body into the ratio 1:3.3; it leads into a muscular vagina 1.3 mm. long by $95\ \mu$ in diameter; this in turn passes gradually into the egg-chamber, which is 1.7 mm. long by $325\ \mu$ broad; the following common trunk is short, and divides into two branches, each of which after a distance of $200\ \mu$ divides again to give rise to the four uteri.

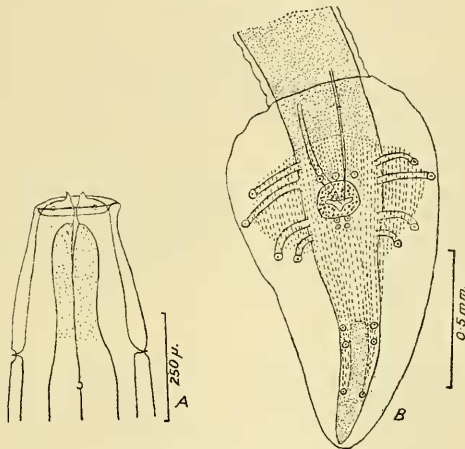
The eggs are oval and very thick-shelled, measuring on an average $55\ \mu$ long by $41\ \mu$ broad, with a shell $9\ \mu$ thick; they are fully embryonated *in utero*.

Male.

The males are respectively 14 mm. and 21 mm. long; they are attenuated only towards the anterior end; the maximum breadth of the larger male is just in front of the bursa, where it is 725μ broad.

The bursa is large, and is nearly twice as long as it is broad; it forms about $1/10\cdot7$ of the body-length. The arrangement of the papillae is similar to that found in *Ph. antarctica* v. Linst., except that the lateral stalked papillae are arranged in two groups, the 1st and 2nd pairs forming a pre-anal group, and the 3rd and 4th pairs forming a post-anal group.

Text-figure 39.

*Physaloptera simplicidens*, sp. n.

A = Ventral view of anterior extremity of body.

B = Caudal extremity of male.

The spicules are slightly unequal, the left being slightly longer and slenderer than the right; their lengths and breadths are respectively 510μ by 38μ and 410μ by 50μ ; both end in fine points, the right, however, being slightly swollen just behind its middle.

Host: "Sleeping Lizard." Australia.

Types in the Helminthological Department of the London School of Tropical Medicine.

Affinities.—The presence of four uteri and a single tooth allies this species to *Ph. colubri* (Rud.), from which species it is, however, distinguished by its much larger size, its relatively much shorter œsophagus, and by the difference in number and arrangement of the post-anal ventral papillae.

GROUP **Polydelphys.**

(28) **PHYSALOPTERA TURGIDA** Rudolphi, 1819. (Text-fig. 40.)

Syn. *Turgida turgida* (Rud., 1819), Travassos, 1920.

Spiroptera turgida (Rud., 1819), Duj., 1845.

The material studied consisted of some excellently preserved specimens in the collection of the Vienna Museum, and of three tubes of material in the collection of Prof. Leiper.

The cuticle is slightly inflated, and is partly reflected over the lips; it is transversely striated by very fine striæ; the cervical papillæ pierce the cuticle just behind the level of the muscular œsophagus, and from 200 to 300 μ further back is the opening of the excretory gland.

The two lateral lips are semi-conical in lateral view; each is surmounted by a large triangular outer tooth having its tip slightly bent outwards; immediately internal to it is a large membranous tooth of equal height and tripartite; no lateral teeth are present. Each lip carries two external papillæ, one subdorsal and one subventral.

The œsophagus is long and straight, widening gradually posteriorly; in the females it varies from $1/4.8$ to $1/5.5$ of the total length, and in the male from $1/3.9$ to $1/5.9$; its muscular portion is thinner than the rest, and forms in the female $1/10$ th and in the male $1/8$ th of the whole organ. The nerve ring encircles it in its posterior third.

Female.

Adult and fully mature females are large and stout, measuring as much as 55 mm. long by 3 mm. broad in their posterior half. The body is attenuated in its anterior half, but posteriorly the thickness is more or less uniform until the vicinity of the anus, where the body tapers suddenly to form a pointed tail $1/45$ th to $1/56$ th of the total body-length, and whose caudal pores are situated in its posterior third.

The position of the vulva varies considerably, but in all cases it was situated behind the end of the œsophagus; it divides the body in the ratio of 1:2 to 1:4.4. The vagina is thick-walled, short, and passes straight back; it is just less than 1 mm. long by 95 μ thick. It passes directly into a larger egg-chamber of about the same length and about 230 μ broad; from the posterior end of this chamber a number of uteri take their origin; because of the complicated manner in which they were entwined, it was not always possible to determine the exact number, but in two specimens it was definitely seen that the one had 11 and the other had 14 uteri. The uteri pass down the body, coiled round each other, almost to the posterior end, when they recurve and join up with the receptacula seminis, which in their turn are united to the ovaries by means of short and thin oviducts. The oviducts pass forwards again to about the middle of the body.

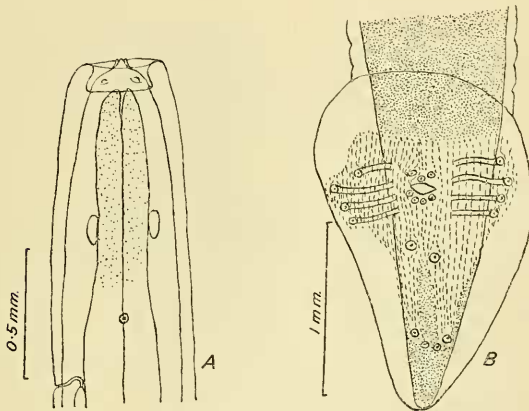
The eggs are oval and thick-shelled and relatively narrow, measuring $48\ \mu$ by $29.5\ \mu$.

Male.

The males are smaller than the females, apparently mature specimens measuring from 21 to 32 mm. long by .950 to 1.25 mm. thick; the body is much more attenuated anteriorly than in the females, this thinning beginning from about the posterior third.

The bursa is large, and has well-developed lateral expansions; the four pairs of pedunculated papillae are equidistant from each other, two pairs being pre- and two pairs being post-anal in position. Of the three pre-anal ventral papillae, the middle one is situated nearer the anus than the other two. Behind the anus there are five pairs of ventral papillae; of these the 1st and

Text-figure 40.



Physaloptera turgida Rud.

A = Lateral view of cephalic extremity.

B = Caudal extremity of male.

2nd pairs are situated immediately behind the anus in a row, the 3rd pair is slightly oblique in position, and the 4th and 5th are situated close together. The ratio of the distances separating pairs 2 and 3, 3 and 4 to 5, and 5 to the tip of the tail is as 1:2:1.

The spicules are of equal length, short, straight, and tubular; each is about $410\ \mu$ long by $32\ \mu$ broad at its base.

The ventral surface of the bursa is covered with longitudinal protuberances.

Hosts: <i>Didelphys cancrivora</i> .	Stomach.	Brazil.
"Manicon."	"	West Indies.
<i>Didelphys virginiana</i> .	"	Michigan.

Affinities.—See *Ph. dilatata*.

(29) *Physaloptera dilatata* Rudolphi, 1819. (Text-fig. 41.)

Syn. *Spiroptera dilatata* (Rud., 1819), Duj., 1845.

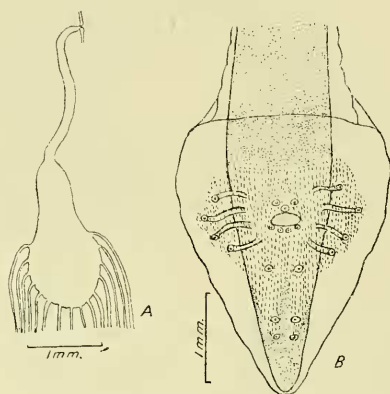
Two males and two females were examined from bottle 4454 in the Vienna Museum. The females were somewhat shrunken, but otherwise the material was in an excellent condition.

The cuticle is finely striated transversely, and is loosely attached to the body; it is reflected over the base of the lips.

The cervical papillæ are situated about $290\ \mu$ behind the level of the posterior limit of the muscular œsophagus, and the excretory pore about another $200\ \mu$ further back.

The two lips are large and semi-rectangular, with projecting dorsal and ventral corners. Each is surmounted by a large conical external tooth, and a tripartite inner tooth of the same

Text-figure 41.



Physaloptera dilatata Rud.

A = Terminal portions of female genitalia.

B = Caudal extremity of male.

height but semi-membranous. No additional teeth are present. Externally each lip has a subdorsal and a subventral dome-like papilla.

The œsophagus is remarkable for its difference in relative length in the two sexes; in the two male specimens examined it formed respectively $1/4\cdot3$ and $1/4\cdot8$ of the total body-length: in the females it is relatively only half this length, forming in the one $1/8\cdot6$ and in the other $1/7\cdot5$ of the total length. Its muscular part is thinner than the following glandular, and forms about $1/10$ th of the whole organ; it is encircled by the nerve ring at the junction of its third and last quarters.

Female.

The females are large and stout, the two specimens measuring

respectively 55 and 90 mm. long, with a maximum breadth of 1.9 and 2.9 mm. respectively; the body is attenuated only in its anterior half, the posterior half being of the same thickness, except for the tail region, where the body tapers abruptly to form a conical tail $1/85$ th of the total length.

The vulva opens very far forwards, being situated in front of the middle of the oesophagus; its position in one specimen divided the body in the ratio of 1:22. It leads into a comparatively straight vagina $2\frac{1}{4}$ mm. long by $115\ \mu$ broad. The following egg-chamber is club-shaped, 2 mm. long by about $840\ \mu$ broad at its widest part; many uteri take their origin from the outer edge of the club; 15 were present in the one specimen, and in the other at least 12 could be made out.

The eggs are oval and thick-shelled, averaging $39\ \mu$ long and $27\ \mu$ broad.

Male.

The males are smaller than the females, measuring respectively 47 and 55 mm. long by 1.45 and 1.6 mm. broad. The body has its maximum breadth just in front of the bursa, and from here the body attenuates gradually towards the anterior end.

The bursa is broad and sharply recurved ventralwards; it forms about $1/16$ th of the body-length, and its ventral surface is covered with longitudinal rows of tubercles. The four pairs of pedunculated papillæ are equidistant, three pairs being pre-anal and the 2nd and 3rd pairs are much longer than the other pairs; of the pre-anal ventral papillæ, the middle one is slightly larger and is situated nearer the anus. There are five pairs of post-anal ventral papillæ, of which the 1st and 2nd pairs are small and situated in a row immediately behind the anus; the 2nd, 3rd, and 4th pairs are equidistant from each other, while the distance between the 4th and last pair is only about a third the distance separating the two preceding pairs.

The spicules appear to be short and equal, but unfortunately the tip of the right spicule was broken off in both specimens, so that it was not possible to determine its correct length; the left spicule was straight and pointed, and measured $655\ \mu$ long by $57\ \mu$ broad at its base; the base of the right spicule had the same thickness as that of the left side.

Host: *Lagothrix humboldtii*. Stomach. Brazil.

Affinities.—This species appears to be closely related to *Ph. turgida*, with which species it agrees in the form of the lips and teeth, general size, and in the anatomy of the female genitalia. It is, however, readily distinguished from this species by the position of the vulva, the difference in the relative length of the oesophagus in the two sexes, and by the position of the 4th and 5th post-anal ventral papillæ on the male bursa.

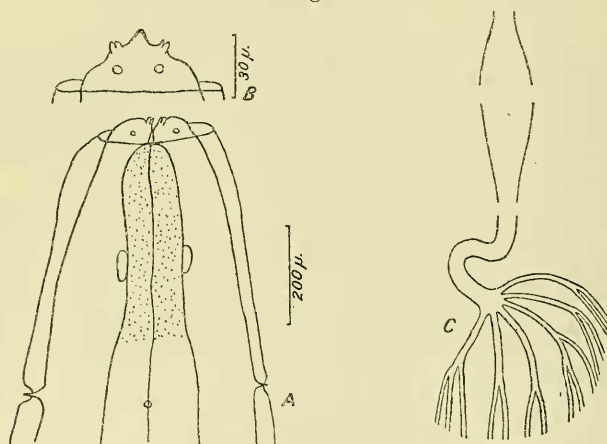
(30) *PHYSALOPTERA CAPENSIS*, sp. n. (Text-figs. 42 & 43.)

The material on which this study is based consisted of one female, two males, and portions of two males.

The cuticle is very finely striated transversely, and is only very slightly reflected over the base of the lips.

The lips are large, and each has on its outer lateral border two dome-like papillæ. The median external tooth is large and is situated on the summit of the lip; its tip is bluntly rounded; immediately internal to it there is another tooth of the same height, but having its tip slightly notched; towards the angles of each lip there is an additional tooth, fairly large, which is generally bifid and may sometimes be irregularly trifid. On

Text-figure 42.

*Physaloptera capensis*, sp. n.

A = Ventral view of anterior extremity of body.

B = Outer lateral view of lip.

C = Terminal portions of female genitalia.

either side of the median tooth there is another bifid tooth, very small and somewhat difficult to make out: it is situated about midway between the median and lateral teeth.

The cervical papillæ and excretory pore are situated at the same level, about $120\ \mu$ behind the junction of the two œsophageal parts.

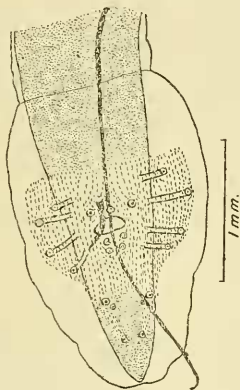
The muscular part of the œsophagus forms about $1/11$ th of the total length of the œsophagus; it is slightly narrower than the following part, and is surrounded in its middle by the nerve ring. The whole œsophagus forms just less than $1/5$ th of the total body-length in the male and $1/10$ th in the female.

Female.

The solitary female is robust, having somewhat the appearance of a short ascarid. It is 56 mm. long, and 1.7 broad in its middle; it is attenuated only very slightly anteriorly.

The vulva is situated flush with the surface and 15.85 mm. from the anterior end; it leads into a long vagina 3.62 mm. long and 152μ broad; this vagina, except for a loop at its end, passes straight down the body to join the egg-chamber; this is also very long but not very broad, measuring 4.86 mm. long by 343μ in diameter. The end of the chamber joins the common trunk, which is 2.19 mm. long and about as thick as the vagina. The rest of the genitalia are remarkable for the number and mode of origin of the uteri; there are 14 uteri arising from six branches, which unite to form the common trunk; four of these branches

Text-figure 43.

*Physaloptera capensis*, sp. n.

Caudal extremity of male.

give rise each to two uteri, whereas each of the remaining two branches give rise to three uteri.

The tail is pointed and 950μ long; the caudal pores open 380μ from its tip.

The eggs are oval and thick-shelled, measuring 55μ long by 32μ broad, and shell 4μ thick.

Male.

The males are much slenderer than the females, measuring 24 mm. long by 900μ broad just behind their middle; they are slightly attenuated anteriorly.

The caudal bursa is large, and twice as long as it is broad; it forms about 1/11th of the body-length; the caudal alæ are well developed, and are supported by the four pairs of pedunculated papillæ, of which two pairs are pre-anal and two pairs post-anal

in position. On the ventral surface there are three pre-anal papillæ immediately in front of the anus, and five pairs of post-anal papillæ. The 1st and 2nd of these last are found close together near the anus; the 3rd and 4th are closely approximated to each other, and are inserted in the middle of the tail; the last pair is situated midway between them and the caudal extremity; the whole ventral surface of the bursa is covered by longitudinal rows of tubercles.

The spicules are unequal, that of the left side being over six times as long as that of the right. The right spicule is fairly stout, measuring 57μ at its base and gradually tapering to a point; it is 420μ long. The left spicule is also pointed, but much slenderer; it is 2.7 mm. long by 27μ broad at its base.

Host: *Xerus setosus*. Stomach. South Africa.

The types to be deposited in the British Museum of Natural History, London.

The mode of origin of the uteri, in conjunction with their number, give this species a unique position in the genus.

The general character of the vagina, egg-chamber, common trunk, and eggs are typical for the genus, so that the presence of numerous uteri is not a sign of very close affinity to the polydelphoid species *Ph. turgida* and *Ph. dilatata*.

(31) *PHYSALOPTERA* sp. (Text-fig. 44.)

The study of this species is based on a single male 15 mm. long and $.65\text{ mm.}$ broad. It was collected from the stomach of a Bandicoot which had died in the Gardens of the Zoological Society of London.

From the middle forwards the body becomes attenuated, but behind the middle the body is of a uniform thickness. The cuticle is finely striated transversely, and is reflexed over the lips so as to completely enclose them. The cervical papillæ are found 457μ from the head end, *i. e.* at the junction of the two œsophageal parts. The excretory pore is situated just behind them.

The mouth is bounded by two large and somewhat conical lips, each surmounted at its apex by a large and triangular outer tooth and immediately internal to it by a median tripartite tooth, of the same height as the outer tooth, but less chitinated. Two external papillæ are present on each lip.

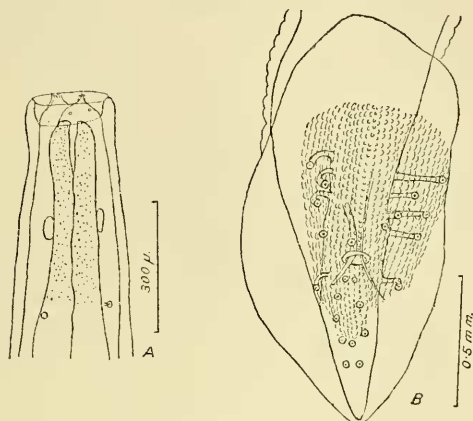
The œsophagus is 3.77 mm. long; its muscular part is thinner and 400μ long, and the nerve ring encircles it just behind its middle.

The caudal bursa is twice as long as it is broad, and it forms $1/9\text{th}$ of the body-length. Its chief characteristic is the irregular arrangement of its papillæ. Of these there are four stalked papillæ on the right side and six on the left. Those of the right side are arranged in a pre-anal group of three, far removed from the anus, and a post-anal papilla; those of the left side are arranged in a pre-anal group of five and a single post-anal papilla. The three pre-anal ventral papillæ are far removed from each

other, the centre one being large and situated nearest to the anus. There are five pairs of post-anal ventral papillæ, situated more or less equidistant from each other; the 2nd, 3rd, and 4th pairs of these are obliquely situated across the tail, whereas the 1st and last pairs are arranged transversely.

The spicules are unequal, the left being longer and slenderer than the right. The right spicule is 370 by 50μ thick at its base; it tapers to a rounded tip. The left spicule is 523μ long by 20μ broad at its base, and tapers to a fine point.

Text-figure 44.

*Physaloptera* sp.

A = Latero-ventral view of cephalic extremity.

B = Caudal extremity of male.

The ventral surface of the bursa is ornamented with longitudinal rows of somewhat rounded tubercles.

Host: *Perameles nasuta*. Stomach. Australia.

I have not attempted to classify this species, because only a single specimen was available for study, and the arrangement of its bursal papillæ differed so much from the typical that I consider the specimen to be abnormal.

PART II.

GROUP *Didelphys*.

(32) *PHYSALOPTERA RARA* Hall & Wigdor, 1918.

Male unknown; length of female 24 mm., maximum thickness 1.34 mm.

Anterior extremity somewhat attenuated. Cuticle strongly annulated, and first annulation behind the head forms a sort of collar, into which the head is partly sunk.

Two lateral lips large, each carrying three prominent inner median teeth and a somewhat smaller external tooth. Each lip with three external papillæ.

Length of œsophagus 1.16 mm.; its muscular part $526\ \mu$ long. Nerve ring near base of muscular œsophagus.

Vulva 3.63 mm. from anterior end. Vagina $880\ \mu$ long. Egg-chamber and common trunk together 2.16 mm. long. Two uteri. Tail blunt and $420\ \mu$ long.

Host: *Canis familiaris*. Duodenum. Michigan.

Hall and Wigdor suggest that this may be an accidental parasite of the Dog. From the remarkable shortness of the œsophagus and the relative length of its muscular part, I suggest that this worm is abnormal, which could easily be accounted for if it was parasitic in a wrong host.

(33) *PHYSALOPTERA TACAPENSIS* Seurat, 1917.

Length of male 15.6 mm., female 22.3 mm.

Cervical papillæ subsymmetrical, at same level as excretory pore immediately behind the muscular œsophagus. External tooth strongly chitinated and truncated; internal tooth of same height. Œsophagus $1/4$ in the male and $1/4.6$ in female of body-length. Female tail short and conical; male tail conical.

Vulva immediately in front of end of œsophagus. Vagina 2.3 mm. long, egg-chamber 1.02 mm. long; common trunk absent. Two uteri. Receptaculum seminis very long. Eggs with very thick shell ($7\ \mu$); $56\ \mu \times 30\ \mu$.

Male caudal bursa with longitudinal cuticular ornamentations. Character and arrangement of bursal papillæ exactly as those in the species described by Seurat (1917 *b*) as *Ph. clausa*.

Right spicule $240\ \mu$ long, thick, and thimble-shaped; left spicule $360\ \mu$ long, slenderer, with conical tip.

Host: *Ctenodactylus gundi*. Stomach. Sud-Tunisien.

From Seurat's description this species appears to be so closely related to his *Ph. clausa* that it appears hardly warrantable to separate the two. The similarity of the teeth, shape of spicules, and arrangement of male caudal papillæ appear to me to be of far greater weight than the slight differences of the relative positions of the vulva, relative lengths of the œsophagus, lengths of the spicules, positions of the cervical papillæ and excretory pore, and the larger egg, all of which differences may very well be due to the fact that the one parasite is about twice the size of the other. In a given species of *Physaloptera* taken from the same host, the differences in size between one adult and another is often very marked, and consequently there is always a certain amount of difference between the individual specimens.

(34) *PHYSALOPTERA GETULA* Seurat, 1917.

Length of male 16.3 mm., female 18.5 mm. $\times 970\ \mu$ thick.

Body stout, attenuated anteriorly; cervical papillæ sub-

symmetrical, far posterior to end of muscular œsophagus and just in front of excretory pore. External tooth conical, slightly shorter than the internal tooth.

Vulva may be found behind œsophagus, but generally it opens in front of its posterior termination, even so far forwards as its middle. Two uteri arise directly from base of egg-chamber. Receptaculum seminis short and ovoid, not constricted off from the uterus.

Egg? Tail short, digitiform, with rounded tip.

Body of male smaller and slenderer than that of female. Bursa ornamented with spines. Three large papillæ just in front of anus; 3rd pair of post-anal papillæ at the level of the 5th pair of external papillæ.

Spicules unequal, right larger and shorter with bent tip, left slenderer and straight. 350 and 480 μ long respectively.

Host: *Mus rattus*. Stomach. Morocco.

(35) *PHYSALOPTERA BREVIVAGINATA* Seurat, 1917.

Only immature female known; 9.8 mm. long \times 444 μ thick.

External tooth strongly chitinated with broad base (surbaissée) and bent outwards. Internal tooth tripartite, and higher than the external tooth; its middle part is bicuspid. Two papillæ to each lip. Œsophagus 1/4th, tail 1/35th of body-length; tail has a rounded tip, and the caudal pores are in its posterior third.

Vulva immediately in front of middle of body, 2.3 mm. from anterior extremity. Vagina very short, 300 μ long; egg-chamber 600 μ long, and its posterior end passes directly into the two uteri.

Host: *Vespertilio kuhlii*. Stomach. Bou-Saâda.

(36) *PHYSALOPTERA ALATA*, var. *CHEVREUXI* Seurat, 1914

Has same character as *Ph. alata*; differs by its smaller size and very posterior position of the cervical papillæ and excretory pore.

Male 7 mm. long \times 515 μ thick. Muscular œsophagus 260 μ . Œsophagus 1/4th of body-length. Cervical papillæ 370 and 360 μ from anterior end; excretory pore 384 μ .

Female (immature). Length 8 mm.; tail long (310 μ) and conical. Vulva a short distance behind end of œsophagus.

Host: Hawk. Bone.

(37) *PHYSALOPTERA ALATA*, var. *NOUVELI* Seurat, 1915.

Large nematodes with robust body and regularly attenuated anteriorly. Cervical papillæ subsymmetrical, situated more or less at the level of the hind end of the muscular œsophagus. Two lateral lips, each with a large triangular external and pointed tooth, and a very small internal tooth with three tips. Œsophagus short, 1/6th of body-length.

Male. Length 22–28.5 mm. \times 900 μ thick. Tail conical and slender, 1.165 mm. long. Circumcloacal area covered with small

cuticular tubercles. (Arrangement of the papillæ as in *Ph. alata*.) Three pre-anal sessile papillæ arranged in a triangle. Four pairs of post-anal ventral papillæ; the 1st and 2nd pairs of these are slightly stalked, and are found on the posterior lip of the cloaca; the last pair is situated just behind the middle of the tail. Five pairs of lateral stalked papillæ grouped about the cloaca, the last inserted at the level of the 3rd pair of post-anal ventral papillæ. Right spicule robust and large, $550\ \mu$ long; left spicule slenderer, feebly chitinated, and longer.

Female 33 mm. long \times 1.055 mm. thick. Tail long, conical, and pointed. Caudal pores in its anterior third. Œsophagus 5.61 mm. long. Vulva in front of termination of Œsophagus, 3.8 mm. from anterior end. Unpaired female genitalia very long; vagina 2.15 mm. long and directed backwards; egg-chamber 3.125 mm. long; trunk $500\ \mu$ long, and divides posteriorly to give rise to two uteri. Receptacula seminis pyriform, $600 \times 325\ \mu$. Egg elliptical, thick-shelled, and embryonated; they measure $50 \times 25\ \mu$.

Hosts: *Aquila chrysaetos*. } Œsophagus. Bou-Saâda.
Accipiter nisus. }

(38) *PHYSALOPTERA SUBALATA* Schneider, 1866.

Length of male 32 mm.

Tips of lips very prominent. Outer tooth longer than inner tooth; edges of smaller teeth quite parallel, and pointed at the tip. Four pairs of stalked circumcloacal papillæ. Three sessile pre-anal papillæ, the middle one nearer the anus; three pairs behind the anus, of which the last two pairs are close together, one pair behind the other, and the last pair nearer the mid-line; the other pair is situated at about the junction of the 1st and 2nd tail thirds.

Host: *Falco* sp. Stomach. Brazil.

With regard to the nature of the teeth, Schneider's description differs from his figure; he states that the outer tooth is larger than the inner, and in his figure shows the outer tooth very much smaller. I take his figure to represent the correct nature of the teeth.

Seurat (1914c) tentatively referred to this species some *Physaloptera* which he obtained from the stomach of a Buzzard, San Martino, Corsica. Briefly he describes this material as follows:—Large and robust body. Two lips, each with a small and cuneiform outer tooth and a large tripartite inner tooth. Œsophagus $1/4.5$ in male, $1/6$ th in female of body-length. Vulva in anterior third of body, 3 mm. behind Œsophagus. Vagina 1 mm., egg-chamber $750\ \mu$ long; trunk divides to give origin to two uteri.

Bursa with four stalked circumcloacal papillæ. Three pre-anal ventral papillæ form a triangle; two pairs immediately behind anus, 3rd pair in middle of tail.

Spicules unequal; left $840\ \mu$ long, slender, and pointed; right less than $400\ \mu$ long, and thicker.

(39) PHYSALOPTERA CROSI Seurat, 1914.

Male 22 mm. long by $660\ \mu$ thick, female 12–22 mm. long.

Two lips, large, each with two external papillæ. External tooth large and triangular; inner median tooth very small and tripartite. Cervical papillæ situated immediately behind level of nerve ring.

Œsophagus $1/6$ th in male, $1/4$ th in female of body-length.

Male bursa plus well-developed alæ, and ornamented with tubercles. Arrangement of its papillæ as in *Ph. galinieri* and *Ph. subalata*, except that an unpaired sessile papilla is present between the last pair of ventral papillæ. Spicules equal, $300\ \mu$ long.

Tail of female short, with caudal glands opening in front of its middle. Vulva in anterior third, 1 mm. behind œsophagus. Vagina shorter than egg-chamber, which is $1200\ \mu$ long \times $300\ \mu$ broad; trunk $400\ \mu$ long, and divides to give rise to the connections of the two uteri. Eggs $55 \times 25\ \mu$, embryonated.

Host: *Accipiter nisus*. Stomach. Mascara.

(40) PHYSALOPTERA GALINIERI Seurat, 1914.

Length, male 21 mm., breadth $780\ \mu$; length, female 17–34 mm. by 1.05 mm. thick.

Two lateral lips, each with a large and very conspicuous tripartite inner tooth.

Œsophagus $1/6$ th in male and $1/7$ th in female of body-length. Cloaca $925\ \mu$ from end of tail in male. Five pairs of stalked papillæ, of which the anterior 4 pairs are arranged circumcloacally, and the last some distance further back. Eleven ventral papillæ, with short stalks and approaching mid-ventral line; of these, 3 are pre-anal, 4 immediately behind the anus in a transverse row, 2 at the level of the posterior pair of circumcloacal stalked papillæ, and 2 midway between the posterior stalked papillæ and tip of tail.

Spicules short, 360 and $380\ \mu$ long.

Vulva a short distance in front of middle of body, far removed from hind end of œsophagus. Ovijector passes forwards; vagina 2 mm. long; egg-chamber oval, $600\ \mu$ long; trunk $200\ \mu$ long. Two uteri, one of which passes forwards and then recurves backwards, whereas the other passes straight back. Receptaculum seminis sharply constricted off from oviduct and uterus, rounded; diameter $240\ \mu$. Eggs $65 \times 35\ \mu$.

Host: Aigle. Œsophagus and stomach. Aïn-Oussera.

(41) PHYSALOPTERA LEPTOSOMA (Gervais, 1848), Seurat, 1917.

Syn. *Strongylus leptosomus* Gervais, 1848.

Ph. chameleontis Geddoelst, 1916.

Length of male 7.8–20 mm., of female 12.5–45 mm.

Two lips; external tooth cuneiform, slightly knobbed at its tip; internal tooth spike-like; lateral teeth bicuspid (these teeth more

or less as in *Ph. paradoxa*, except that inner median tooth is larger); inner denticulate border reduced and interrupted in places.

Muscular œsophagus very short. Œsophagus $1/6$ th in male, $1/10$ th in female. Cervical papillæ asymmetrical, just behind muscular œsophagus.

Vulva at level of end of œsophagus or just posterior: vagina 2.2 mm. long, egg-chamber 925μ long, trunk 500μ long. Two uteri. Receptaculum seminis 400μ long. Eggs $52 \times 35\mu$.

Tail of female elongate and digitiform, with its caudal pores in its posterior third.

Circumcloacal area of male with small tubercles arranged longitudinally; in adult males these are spined.

Male bursa lanceolate; 4 pairs circumcloacal stalked papillæ. Thirteen ventral papillæ; of these, 3 in front of anus, the lateral 2 being shortly stalked; 2 pairs immediately behind anus; 2 pairs just in front of middle of tail, the anterior pair being stalked; 2 papillæ at posterior third of tail. Spicules very unequal; right short and thick, $156 \times 35\mu$; left slender and twelve times as long as the right, 1.92 mm.

Hosts: *Uromastix acanthinurus* and *U. a.* var. *nigriventris*.

Stomach and œsophagus. Algeria.

Varanus griseus. Stomach and intestine. Algeria.

(42) PHYSALOPTERA CHAMÆLEONTIS Gedoelst, 1916.

Syn. *Ph. leptosoma* (Gervais), Seurat, 1917.

Length of male 13.4 mm., of female 22 mm. $\times 815\mu$ thick.

Two hemispherical lips, each with a triangular external tooth. No internal teeth.

Œsophagus of male 1.9 mm., of female 3.7 mm. long; bursa 1.44 mm. long; spicules unequal, right 370μ , left 2.1 mm. long. Arrangement of bursal papillæ as in *Ph. affinis*. Vulva divides body into ratio of 1:4. Two uteri. Eggs $56-63 \times 40-44\mu$.

Host: *Chamæleon gracilis*. Stomach. Belgian Congo.

I agree with Irwin-Smith (1922) that this species is the same as *Ph. leptosoma* (Gervais), Seurat, 1917. The close similarity between Gedoelst's and Seurat's descriptions is very striking. The slight differences in the lengths of the spicules, length of œsophagus, and position of the vulva can very well be accounted for as individual variations.

GROUP Tetradelphys.

(43) PHYSALOPTERA NUMIDICA Seurat, 1917.

Male unknown. Length of female 31.9 mm., thickness 950μ .

Two lips, each with a very large external tooth, a very small inner median tooth, and two bicuspid lateral teeth. Cervical papillæ subsymmetrical and situated far behind the muscular œsophagus, at the level of the excretory pore. Tail short and

conical; caudal pores in its posterior third. Muscular œsophagus short; œsophagus $1/8$ th of body.

Vulva in anterior quarter of body, 3.8 mm. behind œsophagus. Vagina 2.16 mm. long, straight; egg-chamber long; trunk long, and divides dichotomously to give rise to four uteri. Receptaculum seminis oval.

Host: *Dipodillus campestris*. Stomach. Bou-Saâda.

(44) PHYSALOPTERA ABBREVIATA Rudolphi, 1819.

Syn. *Spiroptera abbreviata* (Rudolphi), Duj., 1845.

Body robust. Two lateral lips large. External tooth large, wedge-shaped, and truncated at its tip. Three inner teeth as in *Ph. paradoxa*. Muscular œsophagus thick; nerve ring at its posterior end. Œsophagus long, $1/3.6-1/5.4$ in female, $1/4-1/5.5$ in male of body-length.

Female. Length 7.8–20 mm., attenuated towards both extremities. Tail conical, with caudal pores just behind its middle. Position of vulva variable, opening either in front of or behind end of œsophagus; divides body into ratio of 1:2–1:6. Unpaired female genitalia, very long (3.5 mm.), consist of vagina, egg-chamber, and relatively long trunk. Four uteri arise by dichotomous division of trunk. Receptaculum seminis $150 \times 120 \mu$, sharply constricted off from both uterus and oviduct. Eggs $50-60 \times 37 \mu$.

Male 7.5–11 mm. long. Tail elongate. Caudal alæ large. Cuticular projections small and arranged in rows. Cloacal lips non-salient. Arrangement of papillæ as in *Ph. paradoxa*. Spicules very unequal; left long and filiform, 2 mm. long; right short and stout, $180 \times 45 \mu$. Both pointed.

This description is based on Seurat's (1914 *b*, 1917 *a*) redescrptions of the species from worms obtained from the stomach of *Lacerta ocellata*. Bou-Saâda.

(45) PHYSALOPTERA PALLARYI Seurat, 1917.

Length of male 8.1–10.8 mm., length of female 12.4 (larvæ) to 25 mm.

Two lips, each with its anterior border slightly trilobed. Two external papillæ very small. External tooth triangular, pointed, and recurved. Internal denticulate border formed of twenty sharp denticles. Cervical papillæ at junction of two œsophageal parts; excretory pore at same level or just posterior. Tail of female very short and rounded; caudal pores in its posterior fifth.

Œsophagus long, $1/5$ th in the male, $1/6$ th in the female of body-length.

Vulva $260-1200 \mu$ in front of end of œsophagus. Vagina short, 350μ long; egg-chamber 1.2 mm. long; trunk 650μ long, and divides dichotomously to give rise to four uteri. Eggs $65 \times 32 \mu$.

Male tail massive, with rounded extremity. Anus opens on a large cushion, 100μ in diameter and covered with large warts. First two pairs of stalked papillæ at the same level; 3rd pair at the level of the cloaca; 1st pair post-anal ventral papillæ just behind cloaca, last pair 85μ from caudal extremity. Spicules unequal: right pointed and thick, 150μ long; left slender, 260μ long.

Host: *Agama bibroni*. Stomach and intestine. Marocco.

(46) *PHYSALOPTERA AFFINIS* Gedoelst, 1916.

Length of male 11–13.2 mm., of female 18.7–20.7 mm. \times 8 mm.

Two lateral lips. External tooth large and triangular; no median internal tooth. Œsophagus of σ $1\frac{1}{4}$ 6, of ϕ $1\frac{1}{5}$ 6– $1\frac{1}{6}$ 6 of body-length. Bursa 1.4 mm. long; 2 pre-anal and 2 post-anal stalked papillæ; 3 pre-anal ventral papillæ arranged in a triangle; 2 pairs papillæ close behind anus; 2 pairs close together in middle of tail; 1 pair at junction of last tail quarters.

Spicules unequal, 2.2 mm. and 270μ long; club-shaped plus a conical tip.

Vulva just behind œsophagus or as much as 2 mm. further back. Four uteri. Eggs $56 \times 40\mu$.

Host: *Psammophis sibilans*. Intestine. Belgian Congo.

From Gedoelst's description this species appears to be the same as *Ph. paradoxa* v. Linst. I have examined *Physaloptera* from the same host, and these have been found to belong to von Linstow's species, and consequently Gedoelst's species must be relegated to a synonym of *Ph. paradoxa*.

GROUP Polydelphys.

(47) *PHYSALOPTERA TORRESI* (Travassos, 1920).

Syn. *Turgida torresi* Trav., 1920.

Length of male 35 to 40 mm., of female 70 to 90 mm.; thickness of male 1 to 1.5 mm., of female 2 to 2.5 mm.

Two subtriangular lips, each with four external papillæ and one apical and median papilla. Three teeth present on the tip of each lip, the median being larger and more internal in position than the other two; it is 17μ in length. Lips 85μ high. Œsophagus claviform, 6 to 8 mm. in length, and its muscular part is 400 to 430μ long.

Vulva situated about midway down œsophagus. Egg-chamber gives rise directly to 9 to 11 uteri. Receptaculum seminis pyriform, 870μ long and 380μ thick. Eggs 42 to 49μ long by 28μ in diameter. Anus 780 to 870μ from the posterior extremity.

Male caudal bursa with well-developed ake. Four pairs of lateral circumcloacal pedunculated papillæ. Three sessile papillæ in front of the anus and two pairs of sessile papillæ in a row immediately behind the anus; three further pairs equidistant from each other in the anterior half of the tail. Spicules

subequal and weakly chitinated, 430 to 520 μ long. Anus about 2 to 4 mm. from the caudal extremity.

Host: *Agouti paca*. Stomach. Bahia, Brazil.

Discussion.—This species appears to be very closely related to *Ph. dilatata* Rud., 1819, the only notable difference being the position of 3rd, 4th, and 5th pairs of ventral post-anal papillæ in the male. In *Ph. torresi* these are equidistant from each other, and are situated in the anterior half of the tail, the distance between the 2nd and 3rd pairs being small; in *Ph. dilatata* the distances between the 2nd and 3rd, 3rd and 4th pairs are about equal and long, while that between the 4th and 5th pairs is only about half this distance.

Travassos describes and figures five external papillæ to each lip, but I very much doubt whether his observation is correct, as in all the species of this genus examined by me I have never seen more than two; he also mentions the presence of five similar papillæ in his description of *Ph. turgida*, but, having re-examined my specimens of this species, I still maintain that only two external papillæ are present.

There seem to be some inaccuracies or misprints in Travassos' description of this species. He writes "ovejector com vagina claviforme longa de cerca de 46 mm. de comprimento." I think this should be 4.6 mm., as it is hardly likely that this organ would be about half the length of the worm. Further, with regard to the ventral pre-anal papillæ of the male, the description reads "3 pares situados imediatamente acima do anus." As he figures the usual three papillæ in front of the anus, I think this sentence is intended to convey the fact that three papillæ, not three pairs, are situated in this position. Because of this error, the number of paired papillæ is given as 12 instead of 10 pairs in addition to an unpaired papilla.

With reference to the position of the anus in the male, the description reads that it is "a cerca de 2, a 4 mm. da extremidade posterior." In his French translation this sentence is rendered "à environ 2.4 mm. de l'extrémité postérieure." I am accepting the original to be what Travassos meant, although from the construction of the two sentences it would appear that the translation probably describes the true state of affairs.

It is not perhaps out of place here to draw the attention of those consulting Travassos' original description of this species to the fact that the French translation does not always give a correct rendering of the Portuguese text.

Forms with undetermined number of uteri.

(48) PHYSALOPTERA CAUCASICA v. Linstow, 1902.

Male 14.22 mm. long \times 71 mm. broad; female 27 mm. long by 1.14 mm. thick.

Cuticle unringed. Lips with four submedian papillæ, and large cone-shaped external teeth. Œsophagus 1/5th of body-length.

Male bursa broad anteriorly and narrowed behind; small tubercles on its ventral face. The spicules are unequal, right short and broad, left long and filiform; measure $\cdot 62$ mm. and $1\cdot 76$ mm. long respectively. One pre-anal pair of papillæ (the median probably missed) and five post-anal pairs of ventral papillæ; the arrangement of these papillæ is similar to those found in *Ph. mordens*, except that the relation of the 3rd and 4th pairs to the ventral mid-line is the reverse to that found in *Ph. mordens*. Four pairs of lateral stalked papillæ.

Female tail rounded, $1/53$ rd of body-length. Vulva in the region of union of the 1st and 2nd body sixths. Egg $57 \times 39 \mu$.

Host: *Homo sapiens*. Intestine. Caucasus.

(49) *PHYSALOPTERA DIGITATA* Schneider, 1866.

Length of male 20 mm., of female 27 mm.

Outer tooth small, inner tooth larger than outer, with its tips rounded. Vulva 4 mm. from head end. Of the inner bursal papillæ, 3, 4, and 5 are more or less in a line on the ventral surface. Distance between 4 and 5 smaller than between 3 and 4. Distance from 5 to tip of tail more or less equal to the distance between 3 and 5; 1 and 2 immediately behind anus. Three pre-anal papillæ in a triangle. Four pairs of stalked papillæ; the distance between the most anterior two pairs greater than that separating the others.

Host: *Felis concolor*. Stomach. Brazil.

Ph. terdentata Mol., 1860, was described from the same host, but it appears to be different from *Ph. digitata* Schn., as shown by the difference in arrangement of its post-anal sessile papillæ. The nature of their teeth is, however, very similar.

(50) *PHYSALOPTERA BREVISPICULUM* v. Linstow, 1906.

Male $11\cdot 1$ mm. long \times $\cdot 95$ mm. thick; female $11\cdot 4$ mm. long \times $1\cdot 06$ mm. thick. Each lip with three small peaks (teeth?) on its summit. A preputium-like thickening over the tail is present.

Œsophagus $1/6\cdot 5$, tail in male $1/9\cdot 4$, in female $1/22\cdot 3$ of body-length. Spicules very short, feebly curved, $\cdot 79$ – $\cdot 81$ mm. long. Eggs $36 \times 31 \mu$.

Host: *Felis rubiginosa*. Stomach. Ceylon.

(51) *PHYSALOPTERA GEMINA* v. Linstow, 1899.

Length, male $11\cdot 4$, female 19 mm. \times $\cdot 53$ mm. thick.

Two large conical external teeth; small lateral teeth; more smaller ones internally.

Œsophagus $1/5\cdot 9$, tail of male $1/19$ th, of female $1/35$ th of body-length.

Bursa pointed; 4 pairs lateral stalked papillæ arranged in two groups, 2 pairs pre-anal and 2 pairs post-anal. Eleven ventral papillæ, of which 3 are in a pre-anal row, 2 in a row just behind

the anus, 4 stalked and in a transverse row just in front of middle of tail, 2 stalked and at the junction of last tail quarters.

Eggs $52 \times 32 \mu$.

Host: *Felis catus domesticus*. Stomach and intestine. Egypt.

(52) PHYSALOPTERA CESTICILLATA Somsino, 1889.

Length $1\frac{1}{2}$ –3 mm. and more, slightly attenuated anteriorly, obtuse behind. Two retractile lips, with teeth on its inner front, and with at least one well-developed lateral papilla. A well-defined collar over the lips.

Male. Bursa of variable size, elongate and bent inwards. Four pairs of lateral pedunculate papillæ, and six pairs of ventral sessile papillæ plus two unpaired papillæ, one of which is pre-anal, and the other between the last pair of ventral post-anal papillæ. Except for the posterior unpaired papillæ, the arrangement of the papillæ is similar to that found in *Ph. papillotruncata*. Ventral surface of bursa with longitudinal rows of spikes.

Female immature. Tail mucronate and anus 500μ from its tip.

Host: *Canis cerdo*. Stomach. Egypt.

(53) PHYSALOPTERA TORQUATA Leidy, 1856.

Males unknown. Females .25–.5 inches long by .02 inches thick (3–6 lines \times .25 of a line).

Body cylindrical, attenuated anteriorly; a conspicuous and narrow collar round the head; lips half conical, each with a pair of lateral papillæ and a group of four teeth on its apex, of which one is external to the others. Tail short, conical, obtuse, recurved from the anal aperture.

Host: *Meles labradorica*. Stomach. [America.]

Stossich (1889) lists this species under Sp. Inq., but the nature of the lips and the collar round the head, together with the nature of the teeth, strongly suggest that this species is a true *Physaloptera*.

(54) PHYSALOPTERA MEPHITES Solanet, 1909.

Host: *Mephites suffocans*. Buenos Aires.

(The description of this species, published in the 'Revista del Centro d. Estados d. Agronomia y Veterinaria,' Buenos Aires, was not available for reference.)

(55) PHYSALOPTERA ELEGANTISSIMA Stossich, 1902.

Length of female 50–60 mm. Male unknown.

Body large, cylindrical, and attenuated anteriorly. A large more or less imbutiform cuticular expansion embracing most of the cephalic region except the lips. Two lateral lips, large, and each has three large papillæ—one central and two lateral. External tooth large and conical, supplemented by two subequal denticles. Tail conical and rounded. Eggs smooth and elliptical with very thick shell.

Host: *Ratelus capensis*. Stomach. Eritrea.

(56) *PHYSALOPTERA GUIARTI* Garin, 1913.

Length 35 mm., breadth 2 mm.

Body cylindrical, elongate, and yellowish in colour; transversely striated. Anterior extremity with chitinous expansions. Teeth absent.

Male caudal extremity bent, with margin of alæ lobulated and corrugated; anal aperture in middle of bursa. Four pairs of circumcloacal papillæ. No internal papillæ.

Host: *Leptonychotes weddelli*. Stomach. S. Pole.

From Garin's brief description and crude drawing, this parasite is a *Physaloptera*, but the absence of teeth and internal papillæ on the tail of the male is very remarkable, and suggests the possibility of their having been overlooked.

(57) *PHYSALOPTERA CŒLEBS* v. Linstow, 1897.

Male 7 mm. long \times 5.1 mm. thick. Female unknown.

Œsophagus $1/4.6$, tail $1/15.4$ of body-length.

Four pairs of lateral stalked papillæ. Three pre-anal ventral papillæ arranged in a triangle. Five pairs of post-anal ventral papillæ, of which the last two pairs are stalked; pairs 1 and 2 just behind last pair of lateral papillæ; pairs 3, 4, and 5 in posterior third of tail.

Host: *Centetes ecaudatus*. Madagascar.

(58) *PHYSALOPTERA DISPAR* v. Linstow, 1904.

Length of male 16.6 mm. by 5.3 mm. broad; length of female 25 mm. by 9.5 mm. thick.

Two rounded lips surrounded by a cuticular collar. External tooth rectangular, with two small papillæ on either side; further back there is a larger papilla on either side. Œsophagus in male $1/4.9$, in female $1/6.2$ of body-length.

Tail in both sexes rounded, and forms $1/19$ th in the male and $1/26$ th in the female of the body-length.

Caudal bursa of male with four pairs of elongately stalked papillæ; five sessile papillæ round the anus, one being pre-anal and four being post-anal; four further pairs of post-anal papillæ, of which the most anterior pair is just behind the level of the last pair of stalked papillæ, the 2nd and 3rd pairs close together at about the middle of the tail, and the last towards the tail tip. Spicules very unequal; right broad and .35 mm. long, the left slenderer and .62 mm. long.

Vulva divides the body into ratio of 3:8; eggs thick-shelled and embryonated, $57 \times 39 \mu$.

Host: *Erinaceus albiventris*. Stomach. Nigeria.

Seurat (1917 *b*) has identified this species with his specimens of "*Ph. clausa*." If von Linstow's description of the lips and arrangement of the bursal genital papillæ is correct, then this species cannot be regarded as the same as Seurat's specimens. Consequently, I think that until von Linstow's specimens have

been re-examined, his and Seurat's specimens must be treated as separate species.

(59) *PHYSALOPTERA INCURVA* v. Linstow, 1908.

Length of male 20 mm. by .75 mm. broad; female 47 mm. long by 1.58 mm. thick.

Two lips, dorsal and ventral; each with three teeth.

Œsophagus of male 1/7.6, of female 1/8th, tail of male 1/22nd, of female 1/235th of body-length.

Male bursa with four stalked papillæ—an unpaired pre-anal ventral papilla and three pairs of equidistant post-anal papillæ.

Spicules unequal, right .36 mm. long and broad, left .57 mm. long and narrow.

Vulva divides body into ratio of 34 : 59. Eggs $57 \times 39 \mu$.

Host: *Erinaceus frontalis*. Stomach and intestine. Kalahari.

It is doubtful whether von Linstow's observations in connection with the lips are correct. As all the other characters are typically those of the genus, it is probable that the lips are lateral in position and not dorsal and ventral.

(60) *PHYSALOPTERA CIRCULARIS* v. Linstow, 1897.

Length of male 15.2 mm.; length of female 24 mm. by 1.9 mm. thick.

Two lips, each with two rounded swellings internally, and three external papillæ.

Œsophagus of male 1/4.3, tail of male 1/15.4, tail of female 1/61st of body-length.

Four pairs of circumcloacal stalked papillæ; one pair of sessile papillæ in front of, and an unpaired papilla just behind anus; three pairs of post-anal ventral papillæ, of which pairs 1 and 2 are close together at about the junction of the first two quarters of the tail, and the 3rd at about the middle of the tail.

Eggs with very thick shells, $49 \times 33 \mu$.

Host: *Mus rattus*. Stomach Madagascar.

It is quite possible that von Linstow missed an unpaired pre-anal sessile papilla and four small sessile papillæ just behind the anus. If this should later be found to be the case, then there would be reasonable ground for supposing this species to be either the same as, or very closely related to *Ph. muris-brasiliensis* Dies.

(61) *PHYSALOPTERA RUWENZORII* Parona, 1907.

Length of male $9-9\frac{1}{2}$ mm., of female 14-17 mm.

Body attenuated for a short space anteriorly. Large lips with small papillæ. Teeth large and conical. Œsophagus 1/6th of body-length.

Male caudal bursa large, with large circular expansion anteriorly and conical terminal portion; cuticular ornamentations absent;

four pairs of lateral and circumcloacal stalked papillæ; a large pre-anal unpaired ventral papilla; behind anus two pairs of ventral papillæ and a large unpaired papilla in front of them. Spicules unequal, pointed and slightly bent.

Tail of female long and attenuated. Vulva divides body into ratio of 1:2; it is slightly raised and papillate. Eggs oval, thick-shelled, containing partially developed embryos.

Hosts: *Arvicanthus abyssinicus*. Intestine. Fort Portal, Africa.

Epimys ugandæ (*Mus ugandæ*). Intestine. Fort Portal, Africa.

(Compiled partly from Parona and Hall's (1916) descriptions.)

(62) PHYSALOPTERA SCIURI Parona, 1898.

Length of male 16 mm., of female 17-32 mm.; breadth of male .5 mm., of female .5-1 mm.

Two large and semicircular lips, with foliaceous external tooth.

Caudal bursa of male large and lanceolate; 4 pairs of lateral stalked papillæ situated circumcloacally; a large unpaired papilla close behind the anus; 2 pairs of ventral papillæ situated marginally and at about the middle of the tail; a pair of small ventral papillæ near the tip of the tail. The bursa is ornamented with numerous tubercles. The anus is large and circular, and has a scalloped and raised edge.

Tail of female obtuse. Vulva non-protuberant, and divides the body more or less into the ratio of 1:2. Single uterine tube. Eggs small and spherical, with a diameter of 16-22 μ .

Host: *Sciurus melanogaster*. Stomach and intestine. Mentawai.

As Hall (1916) has pointed out, Parona's observations with regard to the uteri is probably incorrect; in all other Physaloptera in which the number of uteri has been determined they are never less than two.

(63) PHYSALOPTERA INERMIS v. Linstow, 1906.

Length of male 21.5 mm. by 1.26 mm. thick; length of female 51 mm. by 1.62 mm. thick.

Œsophagus of male 1/3.8, of female 1/8.5, tail of male 1/21st, of female 1/425th of body-length.

Bursa with four stalked papillæ on either side and four pairs of equidistant ventral and post anal papillæ; the most anterior of these are situated at about the middle of the tail. Longitudinal striations on alæ.

Spicules 2.37 mm. long.

Vulva divides body into ratio of 11:17. Eggs $47 \times 26 \mu$.

Host: *Sciurus prevosti*. Stomach. Koenigsberg.

(64) PHYSALOPTERA CITILLI (Rud., 1819), Hall, 1916.

Syn. *Spiroptera citilli* Rud., 1819.

Male unknown; female 7-13 mm. long by 400 μ thick.

"Body curved. Anterior extremity very slightly attenuated. Head rounded, continuous with the body, and with the cuticle inflated. Mouth with two large lips. Six head papillæ, of which there are two conical papillæ situated on each side near the angle of contact of the two lips, and one spherical papilla at the base of each lip. Cuticle densely striated transversely. Posterior extremity of female obtuse. Vulva in anterior portion of body."

Host: *Citellus citellus*. Stomach.

Hall (1916) transferred this species to *Physaloptera*, partly on the opinion expressed by Molin and partly because the description could apply to a member of this genus. I follow both these authorities, and consequently list it as a valid member of the genus *Physaloptera*.

(65) PHYSALOPTERA PYRAMIDALIS v. Linstow, 1879.

Length of male 18 mm. by 1 mm. thick; length of female 50 mm. \times 1.5 mm. thick.

Two pyramid-like lips, dorsal and ventral in position. Outer tooth pointed, inner tooth of same size and tripartite. Œsophagus 1/5.7, tail 1/28th in male and 1/55th in female of body-length. Two pre-anal and two post-anal stalked papillæ in caudal extremity of male; in addition 4 pairs of unstalked papillæ, of which one pair is pre-anal and 3 pairs post-anal.

Vulva at junction of 1st and 2nd body fifths. Eggs very thick-shelled, 42 \times 33 μ .

Host: *Cholæpus didactylus*. "An den Selnen der Zehen." Surinam.

This species appears to differ from *Ph. papillotruncata* by its pointed outer tooth and by the more anterior position of the vulva; nevertheless I am inclined to think that this species is identical with or a variety of *Ph. papillotruncata*.

It is possible that von Linstow is mistaken in the position of the lips, and that they are really lateral.

(66) PHYSALOPTERA LIMBATA Leidy, 1856.

Length .5 inch, breadth .02 inch (6 lines \times .25 of a line).

Mouth two-lipped and surrounded by an elevated linear margin. Caudal extremity of male alated and having four pairs of divergent and stalked papillæ.

Host: *Scalops canadensis*. Stomach. Philadelphia.

Molin (1860) lists this species under Sp. Inq.; however, in view of the fact that there are two lips surrounded by what may be interpreted as a cuticular collar, and that the male bursa is alated and has four (pairs) of stalked papillæ, I think there is good ground for supposing that this species is a true *Physaloptera*.

(67) *PHYSALOPTERA NASILIONIS* Gedoelst, 1916.

Larvæ: length 6 mm. Two lateral lips. External tooth triangular. Œsophagus 2.23–2.33 mm. long. Nerve ring in posterior quarter of muscular Œsophagus. Tail conical and blunt, $215\ \mu$ long.

Host: *Nasilio brachyrhynchus*. "Tissu conjonctif." Belgian Congo.

(68) *PHYSALOPTERA BILABIATA* (Creplin, 1829), Dujardin, 1845.

Two large lips, prominent and obtuse. Body much attenuated anteriorly. Caudal extremity of male reflexed, alate, elliptical, with four stalked papillæ. Tail of female conical and obtuse.

Length, ♂ 0.025, ♀ ultra 0.025; breadth 0.001.

Host: *Lanius minor*. Intestine. (Extracted from Stossich's Monograph.)

(69) *PHYSALOPTERA MEGALOSTOMA* Creplin, 1829.

Syn. *Spiroptera megalostoma* Duj., 1845.

Ph. alata Stoss., 1889.

Head naked, with large and simple mouth. Caudal extremity of male with alæ up to its tip; female straight, with rounded extremity.

Host: *Falco nisus*. Proventriculus. Greifsw.

This species is considered by Molin (1860) and Stossich (1889) to be the same as *Ph. alata* Rud.

(70) *PHYSALOPTERA INFLATA* (Mol., 1860), Stossich, 1889.

Syn. *Spiroptera inflata* Mol., 1860.

Length of female 7 mm.; male unknown.

Body striated and attenuated posteriorly. Cuticle of head inflated; no internal teeth on lips. Caudal extremity conical, with an obtuse apex. Vulva in anterior part of body.

Host: *Falco unicinctus*. Stomach and Œsophagus. Brazil.

(71) *PHYSALOPTERA CRASSA* v. Linstow, 1879.

Male 14 mm. long by 1.5 mm. thick; female 23 mm. long by 2 mm. thick.

Lips pyramid-shaped, each with two outer papillæ and two median teeth, of which the inner is tripartite. Œsophagus $1\frac{1}{4}$ – $\frac{7}{8}$ of body-length. Cervical papillæ .6 mm. from anterior end, situated dorsally and ventrally.

Tail of male rounded, $1\frac{1}{11}$ – $\frac{7}{8}$ of body-length. Bursa with six pairs of papillæ, of which the anterior five are stalked and arranged in a longitudinal row close to the anus; the 6th and unstalked papillæ are found on the inner side of the 5th pair. Cirri unequal, .66 and .36 mm. long.

Tail of female rounded, $1\frac{1}{22}$ nd of body-length. Eggs $49\ \mu$ by $26\ \mu$.

Host: *Alauda arvensis*. Intestine. Stuttgart.

(72) PHYSALOPTERA TRUNCATA Schneider, 1866.

Male 25 mm. and female 33 mm. long.

Outer tooth knobbed, "mit beilartiger Schneide." Inner teeth heart-shaped.

Four pairs of lateral and stalked papillæ on male tail; the distance between the 2nd and 3rd somewhat greater than that between the 1st and 2nd, and between the 3rd and 4th. Three pre-anal papillæ in a row, the central one of which is small. The 1st and 2nd pairs of post-anal ventral papillæ small and just behind anus; three larger pairs further down. The ratio of the distances between the 2nd and 3rd, the 3rd and 4th, the 4th and 5th, the 5th and the tip of the tail is about as 1 : 1 : 2 : 2.

Host: *Phasianus gallus*. Stomach. Brazil.

(73) PHYSALOPTERA FUSIFORMIS v. Linstow, 1902.

Male 18 mm. long by 1.38 mm. thick; female 30 mm. long by 1.97 mm. thick.

Two rounded lips, each with three small papillæ on outer edge. Œsophagus of male $1/3.8$, of female $1/5.3$ of body-length; tail of male $1/23$ rd, of female $1/20$ th of body-length. Bursa small and heart-shaped; four pairs of lateral stalked papillæ; one pair of sessile papillæ in front of anus and separated from each other; a pair of sessile papillæ just behind anus; an unpaired papilla in middle of tail, and three more pairs behind it and equidistant from each other.

Vulva in anterior half, and divides body into ratio of 13 : 56. Eggs $81 \times 26 \mu$.

Host: *Micropogon* sp. Breslau Museum.

(74) PHYSALOPTERA DENTATA v. Linstow, 1883.

Male 7 mm. and female 12 mm. long and .96 mm. thick.

Two large lips, each with a large terminal outer tooth and spike-like inner tooth. Cervical papillæ .48 mm. from head end. Œsophagus $1/4.2$, tail of male $1/11$ th, of female $1/25$ th of body-length.

Bursa lanceolate, alæ ornamented with conical tubercles arranged longitudinally; four pairs lateral stalked papillæ, all are pre-anal; one unpaired papilla in front of anus and three pairs behind it; pairs 1 and 2 close together in middle of tail, often fused together; pair 3 at junction of last two tail quarters.

Eggs $52 \times 43 \mu$.

Hosts: *Agama sanguinolenta*. Intestine. Turkestan.

Vipera berus. ?

Phrynocephalus auritus. Mouth and intestine. "

(75) PHYSALOPTERA BRITANICA Skrjabin, 1916.

Length of immature female 42 mm., breadth 6 mm. Male unknown.

Œsophagus 5·44 mm. long. Cervical papillæ ·6 mm. from anterior end. Tail conically pointed, ·46 mm. long. Narrow alæ on both sides of body.

Vulva 4·25 mm. from head end.

Two large lateral lips, each with large external tooth; on inner face a series of smaller triangular and pointed denticles on either side of median tooth; 10-11 of these on either side, and the 5th and 6th of them, from the external tooth end, are large.

Host: *Agama* sp. Intestine. British East Africa.

(76) *PHYSALOPTERA SONSINOI* v. Linstow, 1895.

Length of male 6·5 mm., of female 6·7 mm. and ·48 mm. thick.

A conical tooth on top of each lip.

Œsophagus of male 1/4·6, of female 1/2·75, tail 1/9·25 in male, and 1/18th in female of body-length.

Male caudal bursa elongate; 4 pairs of circumcloacal stalked papillæ; 3 pre-anal sessile papillæ in a triangle; 2 large and oval just behind anus, and slightly further back 2 smaller and rounded papillæ; in middle of tail 4 papillæ in a transverse row, and further back 2 pairs, of which the anterior pair is large, and each papilla of which contains 2 pulps.

Right spicule 1·89 mm. long; left spicule ·32 mm. long and much broader.

Vulva divides body into ratio of 5:31. Eggs $57 \times 39 \mu$.

Host: *Agama mutabilis*. Stomach. Pisa.

Since the spicules are so unequal, it is possible that von Linstow has mistaken the right for the left.

(77) *PHYSALOPTERA ALOISII-SABAUDIÆ* Parona, 1907.

Male 6 mm., female 11 mm. long.

Body attenuated in anterior third. Two large lips with large tooth, and with a series of denticles and one papilla on each lip. Œsophagus 1/4th of body-length.

Male bursa lanceolate; without tubercles on its surface. Anus surrounded by papillæ; four lateral papillæ longly pedunculate; 2nd and 3rd post-anal pair slightly stalked. Spicules large, long, and unequal.

Female with short tail; eggs oval, small, thick-shelled, and embryonated.

Host: *Agama atricollis*. Intestine. Africa.

(78) *PHYSALOPTERA SPIRALIS* Schneider, 1866.

Length of male 14-22 mm.; length of female 29-67 mm.

Outer tooth pointed, inner tooth absent. Inner face of lips provided with denticles. A pair of these behind the tooth in the middle of the lip; on either side of it an additional pair towards the edge of the lips; dorsally and ventrally a row of about five.

Tail of male straight. Four pairs of lateral stalked papillæ; a pair of sessile papillæ in front of anus and 3 pairs post-anal: of these latter the last pair is situated at about the junction of the last tail thirds, and the other two pairs are situated close together just in front of the middle of the tail.

In the largest females the vulva is 10 mm. from the anterior end. Posterior part of body spirally coiled and tail slightly bent dorsalwards.

Host: *Amphisbæna* sp. Stomach. Brazil.

(79) PHYSALOPTERA ANTARCTICA v. Linstow, 1899.

Length of male 27 mm. by .79 mm. thick; female 42 mm. long by 1.18 mm. broad.

Two lateral lips, somewhat rounded; each bears a conical outer tooth and two small inner side teeth.

Œsophagus of male $1/8.3$, of female $1/8.6$ of body-length; tail of male $1/23$ rd, of female $1/54$ th of body-length. Male cloacal aperture large and rounded, and on either side of it four papillæ with long stalks. Thirteen ventral papillæ, of which 3 are pre-anal, 4 just behind the anus in two rows, 2 on either side behind each other in middle of tail, and further back another one on either side.

Tail of female conical, with rounded tip; eggs very thick-shelled, $54-44 \times 42-31 \mu$.

Hosts: *Acanthophis antarctica*. S. Australia.

Cyclodus occipitalis. Œsophagus. S. Australia.

I have identified this species with my specimens from *Varanus varius* and *Python spilotes*.

(80) PHYSALOPTERA ALBA Stossich, 1902.

Male 25-28 mm. long; female 42 mm. long.

Weakly-developed lips, each with two large submedian papillæ and with very weak teeth.

Male bursa lanceolate, with minute ornamentations on its ventral surface. Four pairs of lateral papillæ with long peduncles. Five pairs of ventral papillæ arranged in two groups, viz. three pairs towards the end of the tail and two pairs just behind the anus, of which the outer pair has double pulps.

Tail of female conical. Vulva at the anterior third of the body. Eggs embryonated, elliptical, with very thick shell.

I have identified this species with *Ph. antarctica* v. Linst., 1899.

Host: *Cyclodus boddaertii*. Proventriculus. Nuova Olanda.

(81) PHYSALOPTERA AMPHIBIA v. Linstow, 1899.

Male 12 mm., female 18 mm. long by 1.05 mm. broad.

Two half-rounded lips. External tooth large and cone-shaped, internal tooth small and tripartite. Œsophagus $1/4.4$ in the male and $1/8.3$ in the female of the body-length.

Tail of male $1/15.5$, of female $1/82$ nd of body-length. Bursa with four pairs of stalked lateral papillæ arranged in two groups separated from each other; 1st group of two papillæ is pre-anal, 2nd group is post-anal. Four pairs of ventral sessile papillæ, of which one pair is pre-anal and the other three are in the posterior half of the tail; the central pair of these last three pairs is slightly nearer the front than the hind pair.

Eggs $55 \mu \times 29 \mu$.

Host: *Rana macrodon*. Œsophagus and ventriculus. Luzon.

SPECIES INQUIRENDÆ.

(82) PHYSALOPTERA ABJECTA Leidy, 1856.

Length of female .83 inches, breadth .04 inches (10 lines \times .5 of a line). Male unknown.

"Body most narrowed anteriorly, incurved. Mouth distinctly bilabiate; lips lateral, prominent. Caudal extremity incurved, obtusely conical."

Host: *Psammodiplosis flagelliformis*. Stomach. [U.S.A.]

(83) PHYSALOPTERA BREVICAUDA v. Linstow, 1909.

Two lips widened outwardly, their pulp narrower at its base; a papillæ in their middle, and right and left of it a cone-shaped tooth.

Male 27 mm. long \times .83 mm. thick; female 42 mm. long \times .95 mm. thick. Tail of male rounded, $1/69$ th of body-length.

Bursa somewhat heart-shaped and alæ ornamented with longitudinal striæ. Six pairs of stalked papillæ—4 pre-anal and 2 post-anal; the post-anal pairs are situated in a transverse row just behind the anus. Spicules equal, 1.4 mm. long, and rounded at their tips.

Vulva just behind middle of body; it divides body into ratio 23:21. Eggs $39 \times 26 \mu$.

Host: *Francolinus adspersus*. Intestine. S.W. Africa.

The shape of the lips, arrangement of the male caudal papillæ, length of the right spicule, position of the vulva, and small size of the eggs, seem to indicate that this species is not a Physaloptera. From the description I am not able to place it in any known genus, and consequently list it under Sp. Inq.

(84) PHYSALOPTERA MALLEUS v. Linstow, 1883.

Length of male 20 mm. by .76 mm. thick; length of female 42 mm. by 1.5 mm. thick.

Two very large and rounded lips. Œsophagus $1/6.5$, tail of male $1/33.3$, of female $1/269$ th of body-length. Bursa oval, with rounded prominences arranged in transverse rows. Six pairs of stalked papillæ, of which 4 pairs are pre-anal, and 2 pairs are

post-anal in position ; these last situated just in front of middle of tail. Spicules unequal, the larger having a double barb at its tip. Eggs double-shelled, the outer being the thicker ; they are $46 \times 29 \mu$.

Host: *Corvus cornix*. Turkestan.

This is probably not a Physaloptera, as evidenced by the rounded lips without teeth, the arrangement of the bursal papillæ, and the presence of a hook on the spicule.

(85) PHYSALOPTERA PAPILLORADIATA v. Linstow, 1899.

Length of male 32 mm., of female 56 mm. by 790μ thick.

Two rounded lips.

Œsophagus $1/12$ th, tail of male $1/7$ th, of female $1/127$ th of body-length.

Bursa with 4 pairs pre-anal and 2 pairs post-anal stalked papillæ ; 7 pairs of post-anal ventral papillæ, of which 1 pair is just posterior to the anus, and the remaining 6 pairs are aggregated at the posterior end of the tail.

Eggs $26 \times 12 \mu$.

Host: *Canis lupus*. Pectoral cavity. Persia.

As figured by von Linstow, the arrangement of the caudal papillæ is very similar to that of *Ph. rotundata* v. Linst., except that in *rotundata* there are 5 papillæ at the base of the tail, whereas in *papilloradiata* there are 12. I have placed this species under Sp. Inq. because of this similarity, and because Seurat has found *Ph. rotundata* to be a Habronema.

(86) PHYSALOPTERA SPIRULA Hempr. & Ehrenb., 1828.

Male 6 mm. long ; female unknown. Head continuous with body. Mouth papillate. Caudal extremity of body provided with closed bursal alæ.

Hosts: *Procapra syriaca*. } Large intestine. Syria and Arabia.
Procapra capensis. }

(Extracted from Hall, 1916.)

SPECIES WRONGLY ATTRIBUTED TO THE GENUS.

(87) PHYSALOPTERA ROTUNDATA v. Linstow, 1906.

Length of male 15.6 mm. by 1.1 mm. thick ; length of female 20.3 mm. by 1.5 mm. thick. Both ends of body rounded.

Two large lips, each bearing a prominent papilla on each side. Œsophagus $1/8.6$ in male, $1/9$ th in female, tail in male $1/40$ th, in female $1/20$ th of body-length.

Bursa narrow, with 6 pairs of lateral stalked papillæ, of which 4 pairs are pre-anal and 2 pairs post-anal. Two pairs of ventral papillæ at tip of tail, and just in front of them an unpaired papilla. Spicules unequal ; right 510μ , left 2170μ long, both with rounded tips.

Vulva divides body into ratio of 6:15. Eggs $39 \times 26 \mu$.
Host: *Otis houbara*. Intestine. Koenigsberg.
Seurat (1914 d) has identified this species as a *Habronema*.

(88) *PHYSALOPTERA BULBOSA* v. Linstow, 1906.

Host: *Pavo spicifer*. Stomach.

I have recently found specimens of this parasite in the proventriculus of *Pavo cristatus* from India. From my observations on this material I find that this parasite is not a *Physaloptera*, but belongs to the genus *Cyrnea* Seurat, 1914. A detailed description of it will appear in a later publication.

(89) *PHYSALOPTERA CONTORTA* Leidy, 1856.

"Body capillary, most narrowed anteriorly with the posterior 4/5th spirally contorted; white, with the intestine brown. Lips prominent, constricted from the body, trilobate. Tail short conical, acute, in the male with narrow alæ each furnished with, five funnel-shaped pores. Length of female from 6 lines to an inch; breadth to one quarter of a line; male from one-half to three-quarters of the size."

Hosts: *Emys serrata*, *Emys reticulata*, *Cistudo carolina*, and *Kinosternum pennsylvanicum*. Stomach. [U.S.A.]

Baylis and Lane (1920) suggest that this species is probably identical with or closely related to *Spiroxyys contorta* (Rud., 1819), Schn., 1866. I have been able to examine some specimens of *Spiroxyys contorta* obtained from *Emys orbicularis*, and from my observations Baylis and Lane's view appears justifiable. According to Leidy's description, these parasites must be excluded from the genus *Physaloptera* because of their trilobed lips. Molin (1860) has already doubted the *Physalopteran* affinities of this species.

(90) *PHYSALOPTERA CONSTRICTA* Leidy, 1856.

Length, female $1\frac{3}{4}$ inches, male half as long.

Lips large, lateral, constricted from body, and trilobate. Tail of male with long and narrow turgid alæ; that of the female incurved, conical, and acute.

Host: *Tropidonotus sipedon*. Stomach. [U.S.A.]

The nature of the lips definitely excludes this parasite from the genus *Physaloptera*, no members of it having trilobed lips. Baylis and Lane (1920) suggest that this parasite may be a *Tanqua*. I agree with them in so far that it falls into the family *Gnathostomidae* as redefined by them, but as to its closer relationship to any of the genera of this family, it does not appear justifiable to draw any conclusions; Leidy's brief description of the parasite is equally applicable to the genus *Spiroxyys* as to the genus *Tanqua*.

Molin (1860) also expressed doubt as to this species belonging to the genus *Physaloptera*.

(91) PHYSALOPTERA MUCRONATA Diesing, 1851.

Host: *Alligator mississippiensis*. Georgia.

This parasite has been found by Molin to be an Ascarid, and von Drasche has identified it with *Ascaris lanceolata* Mol., 1860.

(92) PHYSALOPTERA OVATA v. Linstow, 1907.

Length of male 13.8 mm.; length of female 16.8 mm. by 1.22 mm. thick.

Mouth surrounded by 6 cones. Œsophagus of male 1/4.4, of female 1/3.5, tail of male 1/14th, of female 1/53rd of body-length.

Bursa oval, with 5 pairs of equidistant and lateral stalked papillæ, the 2nd being the longest; 2 pairs are pre-anal. Spicules equal 290 μ long.

The vulva divides the body into the ratio of 13:31. Eggs narrow, $42 \times 13 \mu$.

Host: *Astur melanoleucus*. Ventriculus. Cameroon (Kamerun).

The nature of the lips rules this species out of the genus *Physaloptera*; this is supported by the nature of the bursal papillæ and by the extremely narrow egg.

The description is too incomplete to definitely say to which genus it should be transferred, but it appears to have some resemblance to the genus *Cyrnea* Seurat, 1914.

(93) PHYSALOPTERA SAGINATA Rud., 1819.

Syn. *Spiroptera saginata* (Rud.), Duj., 1845.

I examined examples of this species from *Corvus cajanus* and *Caprimulgus guianensis* while at Vienna, and am consequently able to confirm Molin's (1860) view that this species is a *Spiroptera*.

(94) PHYSALOPTERA STRIATA v. Linstow, 1883.

Length of male 18 mm., breadth .48 mm.; length of female 25 mm., breadth .66 mm.

Two dorso-ventral lips, small and rectangular, having a wavy anterior border and divided into three parts internally; 4 small interlabia. Tail of male spirally rolled, 1/37.5 of body-length; tail of female rounded, 1/83rd of body-length.

Caudal alæ of male with longitudinal striations. Four pairs of pre-anal stalked papillæ; 1 unpaired papilla in front of anus; 2 pairs post-anal and dividing tail roughly into thirds.

Vulva divides body into ratio of 3:2. Eggs $46 \times 25 \mu$.

Hosts: *Tropidonotus hydrus*. Turkestan.

Ciconia alba. Stomach. Turkestan.

Seurat has obtained a *Cyrnea* from different species of *Ciconia*, which he identifies with *Ph striata*. This species is undoubtedly not a *Physaloptera*, and from von Linstow's figure and description of the lips I think Seurat is correct in transferring it to his genus.

(95) *PHYSALOPTERA STRONGYLINA* Rud., 1819.Syn. *Spiroptera affinis* Duj., 1845.

Length of male 7·87 mm., of female 15·25 mm. to 20·25 mm.

Body white and head appears to have papillæ; tail of male with lateral alæ, so that it resembles a Strongylid tail. Spicules fairly long and thick.

Host: *Cuculus seniculus*. Stomach and intestine. Brazil.Molin ruled this species out of the genus *Physaloptera*, stating that it belonged to a new genus.

The description is too incomplete to warrant it being referred to any now known Nematode genus.

(96) *PHYSALOPTERA TENUICOLLIS* Rud., 1819.Syn. *Spiroptera tenuicollis* (Rud.), Duj., 1845.

Male unknown; length of female 41 mm., breadth 1·15 mm.

Mouth rounded; anterior end sharply attenuated for a distance of 2·25 mm.

Host: *Falco haliæetus*. Intestine.Molin (1860) has identified this species as an *Ascaris*.

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INDEX TO SPECIES.

	Number	Pages		Number	Pages
abbreviata	44	1087	limbata	66	1095
abjecta	82	1100	longissima	14	1041
acuticauda	18	1050	magnipapilla	21	1058
affinis	46	1088	malayensis	16	1046
alata	7	1025	malleus	84	1100
alata v. chevreuxi	36	1083	maxillaris	4	1019
alata v. novelli	37	1083	megalostoma	69	1096
alba	80	1099	mephites	54	1091
aloisii-sabaudie	77	1098	monodens	9	1030
amphibia	81	1099	mordens	19	1052
anomala	5	1021	macronata	91	1103
antartica	25 & 79	1067	muris-brasilensis	6	1023
bilabiata	68	1096	nasilionis	67	1096
bonnei	11	1034	numidica	43	1086
brevicauda	83	1100	obtusissima	10	1032
brevispiculum	50	1090	ovata	92	1103
brevivaginata	35	1083	pallaryi	45	1087
britannica	75	1097	papilloradiata	85	1101
bulbosa	88	1102	papillotruncata	2	1016
capensis	30	1078	paradoxa	23	1062
caucasica	48	1089	phrynosoma	12	1037
cestitellata	52	1091	praeputialis	15	1043
chamaeleontis	42	1086	pyramidalis	65	1095
circularis	60	1093	quadrovaria	22	1060
citilli	64	1095	rara	32	1081
clausa	1	1012	retusa	8	1027
colebs	57	1092	rotundata	87	1101
colubri	26	1070	ruwenzorii	61	1093
constricta	90	1102	saginata	93	1103
contorta	89	1102	sciuri	62	1094
crassa	71	1096	semilanceolata	3	1017
erosi	39	1085	simplicidens	27	1072
dentata	74	1097	sonsinoi	76	1098
digitata	49	1090	spiralis	78	1098
dilatata	29	1076	spirula	86	1101
dispar	58	1092	striata	94	1103
elegantissima	55	1091	strongylina	95	1104
fusiiformis	73	1097	subalata	38	1084
galinieri	40	1085	tacapensis	33	1082
gemina	51	1090	tenuicollis	96	1104
getula	34	1082	terdentata	17	1048
gracilis	13	1039	torquata	53	1091
guarti	56	1092	torresi	47	1088
incurva	59	1093	truncata	72	1097
inermis	63	1094	tumefaciens	29	1055
inflata	70	1096	turgida	28	1074
leptosoma	41	1085	varani	24	1065